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Technical Report

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PROPULSION SYSTEM PERFORMANCE SIMULATION (PS**2) COMPUTER SIMULATION TO EVALUATE TANK-AUTOMOTIVE ENGINE AND TRANSMISSION PERFORMANCE

A USER'S GUIDE

SEPTEMBER 1988

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This report describes how to use a computer simulation to predict the performance of Army Tank-Automotive equipment. The simulation uses engineering data to predict the gradebility, acceleration and fuel consumption of vehicle propulsion systems. The engine, transmission and intermediate driveline components are simulated mathematically in order to provide an interactive capability. The simulation supports tektronix 4014 terminals and can produce plots of simulation output. The output is also provided in a file which can be sent to a printer.

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Block # 18:

Slope performance

Transmission performance

Engine performance

Performance prediction

PREFACE

This report is an effort to automate the performance evaluation of Army Tank-Automotive vehicles. If during the use of this program any errors are found or there is a need for improvements please feel free to contact the author Richard Jacobson, Systems Simulation and Technology Division (AMSTA-RY), U.S. Army Tank-Automotive Command, Warren, MI 48397-5000

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1.0 INTRODUCTION

This document is a User's Guide which is to be used with the Propulsion System Performance Simulation (PS**2). This simulation is an automated method to evaluate the performance characteristics of different engines and transmissions that are proposed for use in Army tank-automotive equipment. This simulation has been developed by the Propulsion Systems Division of the Research, Development and Engineering Center of the U.S. Army Tank-Automotive Command. The simulation utilizes engineering performance data of vehicles, engines and transmissions to evaluate the performance of complete vehicle systems. The simulation produces text and graphic output to show the performance characteristics of Tractive Force vs Vehicle Speed, Sprocket Horsepower vs Vehicle Speed, Vehicle Speed vs Time, Vehicle Distance vs Time and Vehicle Fuel Consumption. The Tractive Force vs Vehicle Speed and Sprocket Horsepower vs Vehicle Speed listings and graphs are used to evaluate a vehicle's slope-climbing ability. Vehicle full power acceleration information is provided in the form of a listing of vehicle speed and distance and other data for every .1 second. Gaphs of Vehicle Speed vs Time and Vehicle Distance vs Time are plotted from this data. The fuel consumption map consists of lines for sprocket horsepower vs speed for constant fuel consumption. There is one plot for each individual gear range.

The simulation is a computer-based, interactive system which runs on the RDE Center Prime time-sharing computer system; it has recently been updated to make it more user-friendly. No previous computer experience is required by the user. This manual provides the information required to use the PS**2. Actual simulation samples are used extensively in this manual; a sample terminal session is provided in Appendix D for reference.

1.1 SIMULATION PURPOSE

The purpose of the Engine Transmission Performance Evaluation Simulation is to provide engineers with a measuring device to evaluate different vehicle configurations quickly and easily, as well as to provide enough information to make decisions regarding selection of a particular system. The simulation provides access to Vehicle, Engine, and Transmission data that has been compiled by the Propulsion Systems Division.

1.2 BASIC SIMULATION COMPONENTS

There are three basic types of components in this simulation: Vehicles, Engines, and Transmissions. These components are also referred to as "entities." The user is allowed to create, or select from a catalog, each of these components individually to simulate alternative configurations.

The first type of component represents the vehicle characteristics.

These include physical attributes (e.g., weight, frontal area, rolling resistance, etc.) as well as names for an engine and transmission that are standard with the vehicle. Currently, there are approximately 20 vehicles in the AMSTA-RG CATALOG from which to choose.

The second type of simulation entity is the engine. This is the source of power for the simulated vehicle. There are approximately 30 parameters which describe the engine characteristics; many of the attributes are vectors and data arrays. There are now over three dozen engines in the AMSTA-RG CATALOG.

The last simulation component type is the transmission. In addition to the general characteristics, each transmission has an additional set of engine-dependent attributes; there is a separate set of values for each engine with which the transmission can be matched. In this respect, the variety of engines that can be simulated with any given transmission is limited. Presently, the AMSTA-RG CATALOG contains over one dozen transmissions.

1.3 SIMULATION PHILOSOPHY

The simulation has been developed so that an engineer will be able to exercise it and obtain meaningful/satisfactory results. It is written in SIMSCRIPT II.5, a simulation language. Considerable effort and testing have been devoted to making this simulation user-friendly but more suggestions are welcomed. Following are descriptions of features which facilitate ease of use.

1.3.1 SIMULATION PROMPTS. The simulation uses a system of "prompts" to communicate with the user. When the simulation requires information/inputs from you (the user), it will usually request the required information by printing a statement (prompt) at your terminal (e.g., ENTER TERMINAL TYPE) followed by the prompt character, a greater than sign (>). When this character is displayed the computer is waiting for an input from you.

The level of detail provided in the prompts can be specified by the user. There are two levels: full and brief. The prompt level is automatically set to "full" which provides the maximum prompt information. Until you become proficient in the use of this simulation, it may not be wise to change the prompt level.

1.3.2 USER RESPONSES. When entering your responses to the simulation prompts, they should always be in UPPERCASE. Terminals generally have a shift "lock" key. When it is depressed, it will only generate UPPERCASE responses.

If you make a mistake while entering your response, this can be easily corrected. If you have only mistyped a character or two, you can use a character delete to erase the incorrect characters (one for each character to be deleted). If you have typed an incorrect command, you

can use a line delete to erase your entire line. Check the appendix specific to the terminal type you are using to ascertain these deletion characters.

To streamline user responses, most simulation inputs have abbreviations. All recognized abbreviations are displayed next to the full length command; for example, SIMULATE(SIM). In addition, YES can be abbreviated as a Y and NO can be abbreviated as an N throughout the simulation.

Another point to remember is, if you are requested to enter a list of values as your response, these values should be separated by blanks. No other seperator is acceptable; commas should NOT be used.

When you have successfully typed your response to the prompt, it must then be transmitted to the computer. This step is accomplished by entering/depressing the "RETURN" key; this is also known as entering a "carriage return."

The simulation may be terminated by pressing the "BREAK" key. This causes the computer to immediately stop execution of the simulation and returns to the computer operating system. Pressing the "BREAK" key causes a SIMSCRIPT error and a traceback can be be obtained showing where the simulation was when it was stopped. Doing this may cause loss of the vehicle, engine and transmission data that were active in the simulation at that time, if they had not been saved. Normal termination is described in Section 2.4.4.

1.4 MANUAL LAYOUT

The remainder of this manual is organized into four sections. Section 2 presents instructions required to run the simulation. Section 3 stipulates the inputs the user provides; section 4 details the outputs of the simulation. Section 5 provides information regarding errors that can be encountered as well as potential solutions for the user.

Additionally, seven appendices are provided. They are listed below:

- Appendix A - TEKTRONIX Terminal Information
- Appendix B - TAB Terminal Information
- Appendix C - Decwriter (TTY) Terminal Information
- Appendix D - Sample Terminal Session
- Appendix E - Graftek Information
- Appendix F - Fuel Map Information
- Appendix G - Engine/Transmission Matching Information
- Appendix H - Blank Vehicle Data Sheet
- Appendix I - Blank Engine Data Sheet
- Appendix J - Blank Transmission Data Sheet

2.0 EXECUTING THE SIMULATION

This section explains how to execute the PS**2 simulation. The

following four subsections deal with 1) what is necessary before using the computer, 2) logging into the computer, 3) PS**2 initiation, and 4) PS**2 operations. Examples from actual terminal sessions are included.

2.1 BEFORE USING THE COMPUTER

The PS**2 simulation has been developed for the TACOM RDE Center. The TACOM RDE Center Computer consists of three CPU's (Central Processing Units) linked in a network, and housed together in Bldg. 215. Communication between remote computer terminals and the CPU's is via telephone lines. Stationed near each terminal is a modem (modulator/demodulator), which sends and receives computer signals in a form suited to the phone lines. The modem will be either telephone-style (Dataphone) or toggle-switch style (Gandalf).

Prior to running the simulation, you will need to obtain a computer userid and password on the TACOM RDE Center computer. When you are assigned a userid, your file storage area will be assigned to a disk storage unit controlled by either DRAS (Data Reduction Analysis System) or FEM (Finite Element Modeler), two of the three CPU's. Additionally, if you are going to use a dataphone (versus a Gandalf modem) to communicate with the computer, you will need the computer telephone number. All this information can be obtained from your Terminal Area Security Officer (TASO).

2.2 COMPUTER LOGIN

Now you are ready to use the computer. The simulation has been tailored to operate on remote terminals such as a Tektronix 4014, Tab 132-15C, or any (TTY) terminal. Locate one of these terminals. If it has an adjoining Gandalf modem, turn on both the modem and the terminal. If you are using a dataphone, do the following:

1) Turn on the terminal,
2) Dial the computer using the TALK line,
3) Wait for a loud, high-pitched tone (a carrier),
4) Depress the DATA button, then
5) Hang up the phone receiver.

In either case, depress the terminal "RETURN" key. You will be asked to login. Logins are of the form:

    LOGIN userid password -ON cpuname

If you are successful, information will be printed regarding the computer, and an "OK," will appear. If you are unsuccessful, an error message will be printed. You should re-enter the LOGIN line.

2.3 SIMULATION INITIATION

Once you receive the "OK," message, enter SEG <FEM03>JACOBSON>PERFORMANCE>PS**2; and the simulation will begin execution. First a greeting including time of day, date, and simulation consultant is printed, followed by information regarding user input.

2.3.1 INITIAL USER INPUTS. The following is a sample of the simulation initiation. All examples were generated on the TTY type terminal. The examples are printed in all upper case letters.

```
OK, SEG <FEMO3>JACOBSON>PERFORMANCE>PS**2

 WELCOME TO THE PROPULSION SYSTEM PERFORMANCE SIMULATION.
 SIMULATION EXECUTION WAS INITIATED AT 14.55.16   ON 11/21/83.
 IF YOU HAVE ANY DIFFICULTIES USING THIS SIMULATION, CONTACT
 RICH JACOBSON AT EXT. 45879/45999

 IT IS NECESSARY FOR YOU, THE USER, TO PROVIDE SOME INFORMATION
 SO THAT THE SIMULATION CAN TAILOR INPUTS AND OUTPUTS FOR YOU.
 ENTER YOUR RESPONSES FOLLOWING THE ">", AND MAKE SURE THEY
 ARE IN UPPERCASE.  IT IS ALSO NECESSARY TO DEPRESS THE "RETURN" KEY
 TO TRANSMIT YOUR RESPONSE TO THE COMPUTER.
 ENTER THE BAUD RATE IN CHARACTERS PER SECOND (120 OR 960)
>
```

2.3.1.1 BAUD RATE. The baud rate is the speed which information can be transmitted to and from the computer. If you are accessing the computer through a dataphone, then the baud rate is 120. If the connection to the computer is through a Gandalf LDS 120 modem, then the baud rate is 960. The computer prompt is as follows:

```
 ENTER THE BAUD RATE IN CHARACTERS PER SECOND (120 OR 960)
>960
 ENTER TERMINAL TYPE
    1 = TTY
    2 = TEKTRONIX 4014
    3 = RAMTEK 6211
    4 = TAB 132/G
 IF YOU ARE UNSURE OR YOUR TERMINAL TYPE IS NOT LISTED, ENTER 1
 ENTER NUMBER
>
```

2.3.1.2 TERMINAL TYPE. The terminal type will determine if the simulation will be able to provide graphic output. The TTY option is the only option which will not allow graphics. The computer prompt is as follows:

```
 ENTER TERMINAL TYPE
    1 = TTY
    2 = TEKTRONIX 4014
    3 = RAMTEK 6211
    4 = TAB 132/G
 IF YOU ARE UNSURE OR YOUR TERMINAL TYPE IS NOT LISTED, ENTER 1
```

```
ENTER NUMBER
>1
 FOR YOUR CONVENIENCE, THIS SIMULATION CONTAINS A SYSTEM OF
 "PROMPTS" WHICH PROVIDE/REQUEST INFORMATION. THE PROMPT LEVEL IS
 CURRENTLY SET TO PROVIDE THE MAXIMUM AMOUNT OF INFORMATION.  UNTIL
 YOU BECOME PROFICIENT IN THE USE OF THIS SIMULATION, WE RECOMMEND NOT
 CHANGING THE LEVEL OF PROMPTING PROVIDED.
 DO YOU WANT TO CHANGE THE PROMPT LEVEL?  ENTER YES(Y) OR NO(N)
>
```

2.3.1.3 PROMPT LEVEL. The prompt level is the amount of information that is provided when a prompt is given. If the prompt level is changed, prompts will be very short; and it will be expected that the user will know all possible responses. The computer prompt is as follows:

```
 DO YOU WANT TO CHANGE THE PROMPT LEVEL?  ENTER YES(Y) OR NO(N)
>NO
 THIS SIMULATION HAS THE CAPABILITY OF CALCULATING THE TRACTIVE
 FORCE VS VEHICLE SPEED OF AN ENGINE DRIVELINE SYSTEM AND EVALUATING
 THE FULL POWER ACCELERATION AND FUEL CONSUMPTION OF A VEHICLE SYSTEM.
 THE LIST THAT FOLLOWS THIS MESSAGE SHOWS THE AVAILABLE VEHICLES
 (WITH THEIR DEFAULT ENGINES AND TRANSMISSIONS)
 AND OTHER AVAILABLE ENGINES AND TRANSMISSIONS.  NOT ALL COMBINATIONS
 OF ENGINES AND TRANSMISSIONS ARE POSSIBLE.  THE ENGINES THAT HAVE
 BEEN MATCHED WITH A PARTICULAR TRANSMISSION ARE INCLUDED IN THE
 TRANSMISSION DATA.  THERE ARE TWO TYPES OF OUTPUT WITH THIS SIMULATION.
 GRAPHS CAN BE GENERATED WITH THE GRAPH OPTION AND NUMERICAL DATA
 IS OUTPUT TO FILES.  NUMERICAL OUTPUT FOR TRACTIVE FORCE VS SPEED
 IS WRITTEN TO THE FILE TRACTIVE.FORCE.DATA AND THE FULL POWER ACCELERATION
 DATA, AT 0.1 SEC INTERVALS, IS WRITTEN TO THE FILE ACCEL.DATA.
 FUEL CONSUMPTION DATA IN MILES PER GALLON IS WRITTEN ON THE FILE FUEL.DATA.
 A LIST OF VEHICLES, ENGINES AND TRANSMISSIONS WILL BE LISTED
 BY ENTERING A CARRIAGE RETURN.
```

Note that the letter Y can be used in place of YES and the letter N can be used for NO throughout the simulation.

At this point the user should respond by entering a carriage return. Now all initial inputs have been entered, and you are ready to utilize the data handling and evaluation capabilities of this simulation.

2.3.2 CATALOGS. At this point in the simulation, the option to view the AMSTA-RG CATALOG or the USER CATALOG of data is provided as well as the opportunity to recall data from them. The AMSTA-RG CATALOG contains data for Vehicles, Engines, and Transmissions that has been compiled by the Propulsion Systems Division. The USER CATALOG contains data that an individual user has created and stored under the user's UFD (User File Directory) where he executes the simulation. Data from the AMSTA-RG CATALOG can be recalled, but no user created data can be saved in the

AMSTA-RG CATALOG. User data can be saved in the USER CATALOG. These are files in the user's UFD where the user started the simulation. The file names are VEHICLE.DATA, ENGINE.DATA, and TRANS.DATA. The simulation will ask the user if he wants to see the AMSTA-RG CATALOG via the prompt which follows:

DO YOU WANT TO SEE THE AMSTA-RG CATALOG ? YES(Y) OR NO(N)
>YES

AMSTA-RG CATALOGED DATA

VEHICLE WITH ENGINE AND TRANSMISSION			ENGINES	TRANSMISSIONS
M-60	AVDS-1790	CD-850-6A	RC4-350.RO	TX-100-1A
M-48	AVDS-1790	CD-850	6V53	X-1100
M-113-ITV	6V53	TX-100-1A	AGT-1500	X-300W/OTC
M113-A1	6V53	TX-100-1A	MTU-871HOT	X-300
XM-1	AGT-1500	X-1100	MTU-880CLD	RENK-304
M-1	AGT-1500	X-1100	RR-CV12HOT	AMX-1000
XM-723.TB	RC2.350TCB	X-300.RC2E	GT-601	AMX-NO.TC
M-48.A5	AVDS-1790	CD-850	GT-601.MKI	X-300.RC
DIVADS	AVDS-1790	CD-850	GT-601.MIF	CD-850-6A
M-60.A3	AVDS-1790	CD-850-6A	ADIA.4CYL	HMMWV;GMHY
M-60.AX.A	AVDS-1790	CD-850-6A	ADIA.6CYL	X-250
M-60.AX.B	AVDS-1790A	CD-850-6A	ADIA.8CYL	ATT-464
M-60.AX.C	AVDS-1790A	CD-850-6A	LCR.903.8	NP435
LVTP7	RC2-350.65	X-300.RC2E	GT-601.800	
M-1.62	NONE	NONE	RC2.350TC	
HMMWV;GM	HMMWV;GM62	HMMWV;GMHY	RC2.350TCA	
MPG.TEST	GT-601	X-250	GT-601.MIB	
HSTVL	AVCO-650	X-300	AVCR-1790	
RAM	318	NP435	V-903.800	
			(More Not Shown)	

A "NO" user response (which is demonstrated below) will cause the USER CATALOG to be displayed. The USER CATALOG is a list of that data which has been saved in files under the user's UFD.

DO YOU WANT TO SEE THE AMSTA-RG CATALOG ? YES(Y) OR NO(N)
>NO

USER CATALOGED DATA

VEHICLE WITH ENGINE AND TRANSMISSION			ENGINES	TRANSMISSIONS
M-60	AVDS-1790	CD-850-6A	AVDS-1790	CD-850-6A
M-1	AGT-1500	X-1100	AGT-1500	X-1100
RAM.1	318	NP435	318.1	NP435.1
M-1.X	AGT-1500	X-1100	AGT-1500.X	X-1100.X

```
DO YOU WANT TO RECALL A VEHICLE, ENGINE OR TRANSMISSION AT THIS TIME
YES(Y) OR NO(N)
>
```

The simulation has been set up so that cataloged data can be recalled from a file at this time. If data is not recalled, the simulation goes to the top-level prompt, which follows:

```
DO YOU WANT TO RECALL A VEHICLE, ENGINE OR TRANSMISSION AT THIS TIME
YES(Y) OR NO(N)
>NO
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>
```

However, if the response was "YES", the simulation then enters the RECALL segment. See the section pertaining to the RECALL command for proper responses. After data is recalled the simulation returns to the top-level prompt.

2.4 SIMULATIONS OPERATIONS

The user is able to control the simulation operations via a hierarchy of commands. This structure is shown below:

USER COMMAND HIERARCHY

```
TOP LEVEL CONTROLLER COMMANDS:
o   COMPONENT(CD)
o   SIMULATE(SIM)
o   GRAPH(G)
o   STOP(S)

    COMPONENT DATA MANAGEMENT COMMANDS:
    o   QUERY(Q)
    o   RECALL(R)
        o   VEHICLE(V)
        o   ENGINE(E)
        o   TRANS(T)
        o   RETURN(RET)
    o   LIST(L)
        Same options as RECALL above
    o   CHANGE(CH)
        Same options as RECALL above
    o   SAVE(S)
        Same options as RECALL above
    o   DELETE(D)
        Same options as RECALL above
    o   CREATE(CR)
        Same options as RECALL above
```

- o RETURN(RET)

SIMULATION FACILITY CHOICES
- o 1=FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
- o 2=FULL POWER ACCELERATION PERFORMANCE
- o 3=FUEL CONSUMPTION
- o 4=RETURN

GRAPHING FACILITY CHOICES
- o 1=TRACTIVE FORCE VS VEHICLE SPEED
- o 2=ACCELERATION DISTANCE VS TIME
- o 3=ACCELERATION VEHICLE SPEED VS TIME
- o 4=SPROCKET HORSEPOWER VS VEHICLE SPEED
- o 5=FUEL CONSUMPTION IN CONSTANT MPG
- o 6=RETURN

There are three groups of commands: database commands, simulate commands, and graph commands. This section presents all available commands as well as a brief description of the resulting operations. Additionally, examples of command usage are provided.

After the initial user inputs (e.g., baud rate, terminal type) have been entered, the simulation will place the user at the "TOP LEVEL CONTROLLER" level. From this level, the user can invoke any of the three major command groups (database, simulate, or graph) or terminate simulation execution. The prompt which informs the user that he is at the TOP LEVEL CONTROLLER follows:

```
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>
```

2.4.1 COMPONENT DATA COMMAND. The database section of the simulation allows the user to access all of the available data and perform various operations on it. The user is free to use the commands in any order desired, and he can re-enter them as well. Each operation is listed with an explanation of its use as well as examples of the computer interactions. The database segment prompt is as follows:

```
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
 RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.1 QUERY. The QUERY command allows the user to display a list of the Vehicles, Engines, and Transmissions that are on the AMSTA-RG CATALOG or the USER CATALOG. The following example shows a query of the AMSTA-RG CATALOG:

```
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
 RECALL(R)   DELFTE(D)   QUERY(Q)   RETURN(RET)
>QUERY
 DO YOU WANT TO SEE THE AMSTA-RG CATALOG ?  YES(Y) OR NO(N)
>YES
                      AMSTA-RG CATALOGED DATA
-----------------------------------------------------------------
 VEHICLE WITH ENGINE AND TRANSMISSION   ENGINES     TRANSMISSIONS
 ------------------------------------   ----------  -------------
   M-60        AVDS-1790   CD-850-6A    RC4-350.RO    TX-100-1A
   M-48        AVDS-1790   CD-850       6V53          X-1100
   M-113-ITV   6V53        TX-100-1A    AGT-1500      X-300W/OTC
   M113-A1     6V53        TX-100-1A    MTU-871HOT    X-300
   XM-1        AGT-1500    X-1100       MTU-880CLD    RENK-304
   M-1         AGT-1500    X-1100       RR-CV12HOT    AMX-1000
   XM-723.TB   RC2.350TCB  X-300.RC2E   GT-601        AMX-NO.TC
   M-48.A5     AVDS-1790   CD-850       GT-601.MKI    X-300.RC
   DIVADS      AVDS-1790   CD-850       GT-601.MIF    CD-850-6A
   M-60.A3     AVDS-1790   CD-850-6A    ADIA.4CYL     HMMWV.GMHY
   M-60.AX.A   AVDS-1790   CD-850-6A    ADIA.6CYL     X-250
   M-60.AX.B   AVDS-1790A  CD-850-6A    ADIA.8CYL     ATT-464
   M-60.AX.C   AVDS-1790A  CD-850-6A    LCR.903.8     NP435
   LVTP7       RC2-350.65  X-300.RC2E   GT-601.800
   M-1.62      NONE        NONE         RC2.350TC
   HMMWV.GM    HMMWV.GM62  HMMWV.GMHY   RC2.350TCA
   MPG.TEST    GT-601      X-250        GT-601.MIB
   HSTVL       AVCO-650    X-300        AVCR-1790
   RAM         318         NP435        V-903.800
                                        (More Not Shown)
```

The next example shows a query of the user's local data files (USER CATALOG).

```
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
 RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>QUERY
 DO YOU WANT TO SEE THE AMSTA-RG CATALOG ?  YES(Y) OR NO(N)
>NO
                      USER CATALOGED DATA
-----------------------------------------------------------------
 VEHICLE WITH ENGINE AND TRANSMISSION   ENGINES     TRANSMISSIONS
 ------------------------------------   ----------  -------------
   M-60        AVDS-1790   CD-850-6A    AVDS-1790     CD-850-6A
   M-1         AGT-1500    X-1100       AGT-1500      X-1100
   RAM.1       318         NP435        318.1         NP435.1
```

```
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)    LIST(L)    CHANGE(CH)    SAVE(S)
 RECALL(R)    DELETE(D)    QUERY(Q)    RETURN(RET)
>
```

The query command automatically returns to the COMPONENT DATA HANDLER.

2.4.1.2 RECALL. The RECALL command allows the user to recall data from the AMSTA-RG CATALOG or previously saved data from his own USER CATALOG. Only one copy of each component type (Vehicle, Engine, and Transmission) can be available to the simulation at a time. Therefore, the existing data for a component must be deleted from the simulation before other data can be recalled.

The following example illustrates data being recalled from a file. First, the simulation asks if the AMSTA-RG CATALOG is to be used. The user responds "YES"; however, if the user would have responded "NO", his own USER CATALOG would have been used. The RECALL options are then printed. The user requests a vehicle be recalled and is prompted by the simulation for the vehicle name. Next an engine recall is requested. The simulation now asks the user if the default engine (AGT-1500) is to be recalled. This is responded to affirmatively by the user. Next, a transmission recall is requested by the user. Again, a default one (X-1100) is available; and the simulation asks if that one should be recalled. The user responds positively.

```
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)    LIST(L)    CHANGE(CH)    SAVE(S)
 RECALL(R)    DELETE(D)    QUERY(Q)    RETURN(RET)
>RECALL
 DO YOU WANT DATA FROM THE AMSTA-RG CATALOG YES(Y) OR NO(N)
>YES
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)    ENGINE(E)    TRANS(T)    RETURN(RET)
>VEHICLE
 ENTER THE VEHICLE NAME
>M-1
 THE VEHICLE M-1          WAS LOADED FROM THE FILE
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)    ENGINE(E)    TRANS(T)    RETURN(RET)
>ENGINE
 DO YOU WANT THE VEHICLE DEFAULT ENGINE LOADED YES(Y) OR NO(N)
>YES
 THE ENGINE AGT-1500    WAS LOADED FROM THE FILE
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)    ENGINE(E)    TRANS(T)    RETURN(RET)
>TRANS
 DO YOU WANT THE VEHICLE DEFAULT TRANSMISSION LOADED YES(Y) OR NO(N)
>YES
 THE TRANSMISSION X-1100      HAS BEEN LOADED
```

At this point, the desired recalls have been performed so a "RET" response is entered by the user to return to the COMPONENT DATA HANDLER level.

```
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.3 LIST. The LIST option allows the user to list the Vehicle, Engine, or Transmission data that is presently available to the simulation. The following example shows a display of vehicle data.

```
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>LIST
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
   VEHICLE NAME                          = M-1
   DEFAULT ENGINE                        = AGT-1500
   DEFAULT TRANSMISSION                  = X-1100
   GROSS VEHICLE WEIGHT                  = 120000     LB
   PRIMARY ROAD ROLLING RESISTANCE       =     90     LB/TON
   SECONDARY ROAD ROLLING RESISTANCE     =    100     LB/TON
   CROSS COUNTRY ROLLING RESISTANCE      =    180     LB/TON
   FRONTAL AREA                          =     80     FT**2
   AIR DRAG COEFFICIENT                  =      1.300
   ACTIVE TRACK WEIGHT                   =   8944     LB
```

The next example shows a display of engine data.

```
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 ENGINE NAME = AGT-1500

   ENG MAX GROSS HP      = 1500    HP
   ISTAL LOSS FACTOR     = 0.967
   STD TEMPERATURE       =   60    DEG F
   ALTITUDE              =    0    FT
   RATED ENG RPM         = 3000    RPM
   ENG IDLE RPM          = 1000    RPM
   ENG SPEED FOR SHIFT   = 2950    RPM
```

ENGINE RPM VS CROSS TORQUE MATRIX

RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF
800	4450	1000	4300	1200	4150	1400	4000
1500	3940	1600	3850	2000	3550	2400	3200
2800	2790	3000	2625				

COEFF'S TO TEMP AND ALTITUDE CORRECTION FACTOR CURVES

	CONSTANT	X	X**2	X**3
TEMP	0.141861E+01	-0.46512E-02	0.000000E+00	0.000000E+00
ALTITUDE	0.100000E+01	-0.32500E-04	0.000000E+00	0.000000E+00

ALTITUDE CORRECTION OF FULL POWER	TEMPERATURE	TEMPERATURE CORRECTION	
100	0	100	60
97	1000	100	70
93	2000	100	80
90	3000	100	90
87	4000	95	100
84	5000	91	110
80	6000	86	120
77	7000	81	130
74	8000	77	140
71	9000	72	150

COEFFICIENTS TO ENGINE TORQUE LOSS CURVES

	CONSTANT	X	X**2	X**3
ACC	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
ALT	0.115280E+03	-0.23415E-01	0.000000E+00	0.000000E+00
ENG FAN	0.000000E+00	0.145049E-02	0.186072E-04	0.150022E-09

ACCESSORY		ALTERNATOR		ENGINE FAN	
RPM	TQ	RPM	TQ	RPM	TQ
400	0	400	111	400	1
600	0	600	106	600	4
800	0	800	101	800	8
1000	0	1000	97	1000	13
1200	0	1200	92	1200	20
1400	0	1400	87	1400	29
1600	0	1600	82	1600	39
1800	0	1800	78	1800	51
2000	0	2000	73	2000	64
2200	0	2200	68	2200	79
2400	0	2400	64	2400	95
2600	0	2600	59	2600	113
2800	0	2800	54	2800	132
3000	0	3000	50	3000	153
3200	0	3200	45	3200	176

```
FUEL CONSUMPTION HORSEPOWER STEP SIZE IS     100
FUEL CONSUMPTION SPEED STEP SIZE IS          300

ENGINE FUEL CONSUMPTION MAP
1500|  1.41 1.26 1.11 0.96 0.81 0.66 0.60 0.56 0.52 0.50 0.50
1400|  1.30 1.17 1.04 0.91 0.78 0.66 0.59 0.55 0.51 0.49 0.48
1300|  1.20 1.09 0.98 0.87 0.76 0.65 0.58 0.53 0.49 0.48 0.48
1200|  1.09 1.00 0.91 0.82 0.73 0.64 0.57 0.51 0.49 0.48 0.48
1100|  0.99 0.92 0.84 0.77 0.70 0.63 0.55 0.51 0.49 0.48 0.48
1000|  1.06 0.97 0.88 0.79 0.71 0.62 0.54 0.52 0.50 0.49 0.49
 900|  1.28 1.14 0.99 0.85 0.70 0.62 0.56 0.52 0.51 0.50 0.50
 800|  1.30 1.15 1.00 0.84 0.69 0.61 0.56 0.53 0.52 0.52 0.52
 700|  1.25 1.11 0.97 0.83 0.68 0.61 0.58 0.55 0.54 0.53 0.54
 600|  1.22 1.09 0.96 0.83 0.70 0.63 0.59 0.57 0.56 0.56 0.57
 500|  1.19 1.07 0.95 0.84 0.71 0.64 0.61 0.59 0.59 0.59 0.61
 400|  1.42 1.24 1.06 0.87 0.74 0.67 0.64 0.63 0.63 0.64 0.67
 300|  2.26 1.63 1.00 0.91 0.77 0.70 0.69 0.69 0.70 0.72 0.76
 200|  2.08 1.65 1.22 0.98 0.83 0.78 0.78 0.80 0.85 0.90 0.95
 100|  1.91 1.66 1.44 1.11 1.00 1.00 1.14 1.19 1.28 1.43 1.46
   0|  1.73 1.68 1.66 1.68 1.95 1.95 1.85 2.14 2.00 2.14 2.03
    +-----------------------------------------------------------------
          0  300  600  900 1200 1500 1800 2100 2400 2700 3000
       ENGINE HORSEPOWER VS ENGINE RPM
```

The final list example presents transmission data:

```
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 DATA FOR TRANSMISSION X-1100
 WHICH HAS BEEN MATCHED WITH THE FOLLOWING ENGINES
 NUMBER  ENGINE NAME
 ------  -----------
    1    RC4-350.RO
    2    AGT-1500
    3    TWIN-903.1
    4    TWIN-903.2
    5    TWIN-903'S
    6    ONE.903.1
    7    ONE.903.2
    8    ONE.903.3
    9    MTU-871HOT
   10    AVCR-1360
   11    MACK-E-9
   12    TWIN-903'S
   13    TWIN-E-9'S
   14    TWIN-903.1
   15    TWIN-903.2
   16    ONE.903.1
   17    ONE.903.2
   18    ONE.903.3
```

```
  19    RR-CV12HOT
  20    MTU-880HOT
  21    MTU-880CLD
  22  TO RETURN
ENTER NUMBER TO LIST DATA OR RETURN
>2
TRANS NAME = X-1100     HYDROKINETIC    WITH TC-897-3B CONVERTER

  TRANSMISSION GEAR SHIFT TIME         =     0.05  SEC
  TRANSMISSION MOMENT OF INERTIA       =     3.000 FT-LB-SEC**2

DATA FOR AGT-1500   ENGINE

  ENGINE TO TRANS GEAR RATIO AND EFFICIENC=       1.000    1.000
  TRANSFER CASE GEAR RATIO AND EFFICIENCY =       1.000    1.000
  FINAL DRIVE GEAR RATIO AND EFFICIENCY   =       4.300    0.980
  FINAL DRIVE MOMENT OF INERTIA           =       7.520 FT-LBF SEC**2
  SPROCKET PITCH RADIUS                   =       1.120 FT
  NUMBER OF GEARS =    4    STARTING GEAR    =  2

           ENGINE  SPEED                     TRANS
           SPEED   RATIO   TRANS   TRANS    GEAR
            FOR     FOR    GEAR    GEAR     MNT OF
 GEAR MODE LOCKUP  LOCKUP   EFF    RATIO    INERTIA
   1    1   2900   0.860   0.940   5.880   110.00
   2    3   2900   0.860   0.940   3.020   25.000
   3    3   2900   0.860   0.940   1.890   13.000
   4    3   2900   0.860   0.950   1.280   10.000

   0.870 IS THE SPEED RATIO AT WHICH THE
   INPUT CAPACITY FACTOR AND TORQUE RATIO
   CURVES CHANGE

  COEFFS TO THE TWO SPEED RATIO VS TORQUE RATIO CURVES
  CONSTANT              X              X**2             X**3
CURVE 1 0.230000E+01 -0.14800E+01 0.319541E+00 -0.38609E+00
CURVE 2 0.717278E+02 -0.23019E+03 0.249618E+03 -0.90207E+02

  COEFFS TO THE TWO SPEED RATIO VS INPUT CAPACITY FACTOR CURVES
CURVE 1 0.283000E+02    0.297630E+02    -0.10040E+03    0.113204E+03
CURVE 2 -0.46522E+05    0.156412E+06    -0.17531E+06    0.655903E+05

  COEFFS TO THE TWO SPEED RATIO VS OUTPUT CAPACITY FACTOR CURVES
CURVE 1 0.572476E-02    0.497067E-01    -0.10521E-02    0.835641E-05
CURVE 2 0.487245E+00    0.137330E-01    -0.13790E-03    0.483642E-06

SPEED RATIO  TORQUE RATIO  INPUT CAPACITY    SPEED RATIO  OUTPUT CAPACITY
   0.00          2.30          28.3             0.01            0.0
   0.10          2.15          30.4             0.65           20.0
   0.20          2.01          31.1             0.85           40.0
   0.30          1.87          31.2             1.00           60.0
```

0.40	1.73	31.4	0.95	80.0
0.50	1.59	32.2	0.97	100.0
0.60	1.44	34.5	0.99	120.0
0.70	1.29	38.8	1.00	140.0
0.80	1.12	45.8	1.00	160.0
0.90	0.99	59.4	1.00	180.0
1.00	0.95	165.9	1.00	200.0

TRANSMISSION FAN TORQUE LOSS COEFFICIENTS

0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE

CONVERTER

0.388960E+02 0.355505E-01 -0.10646E-05 0.000000E+00

LOCKUP

0.388960E+02 0.355505E-01 -0.10646E-05 0.000000E+00

RPM	TRANS FAN LOSS	INPUT LOSS CONV	INPUT LOSS LOCKUP
0	0.0	38.9	38.9
200	0.0	46.0	46.0
400	0.0	52.9	52.9
600	0.0	59.8	59.8
800	0.0	66.7	66.7
1000	0.0	73.4	73.4
1200	0.0	80.0	80.0
1400	0.0	86.6	86.6
1600	0.0	93.1	93.1
1800	0.0	99.4	99.4
2000	0.0	105.7	105.7
2200	0.0	112.0	112.0
2400	0.0	118.1	118.1
2600	0.0	124.1	124.1
2800	0.0	130.1	130.1
3000	0.0	136.0	136.0

COEFFICIENTS FOR TRANS OUTPUT TORQUE LOSS CURVE

'GEAR	CONSTANT	X	X**2	X**3
1	0.370579E+02	0.327095E-01	0.114288E-05	0.280044E-09
2	0.489163E+02	0.400539E-01	-0.15701E-04	0.455355E-08
3	0.818664E+02	0.256677E-01	-0.19742E-04	0.630666E-08
4	0.970775E+02	0.977782E-02	-0.17140E-05	0.426055E-08

TRANSMISSION OUTPUT TORQUE LOSS

RPM	'GEAR 1	'GEAR 2	'GEAR 3	'GEAR 4	'GEAR 5	'GEAR 6
0	37	49	82	97	0	0
200	44	56	86	99	0	0
400	50	63	89	101	0	0
600	57	68	92	103	0	0
800	64	73	93	106	0	0
1000	71	78	94	109	0	0
1200	78	82	95	114	0	0
1400	86	87	96	119	0	0

1600	93	91	98	126	0	0
1800	101	97	101	134	0	0
2000	109	103	105	144	0	0
2200	118	110	110	156	0	0
2400	126	118	117	170	0	0
2600	135	127	126	186	0	0
2800	144	138	137	205	0	0
3000	153	151	151	226	0	0

TRANSMISSION SHIFT SCENARIO
GEAR 2 CONVERTER
GEAR 2 LOCKUP
GEAR 3 LOCKUP
GEAR 4 LOCKUP

TRANSMISSION GEAR SHIFT VALUES

GEAR	2 CONV		2 LU		3 LU		4 LU	
	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
	0.0	7	0.0	12	0.0	19	0.0	45
	275	7	175	12	175	19	950	45
	950	11	700	18	700	28	950	45
	950	11	1025	18	1000	28	950	45

At this point you are given an opportunity to continue listing components or to return to the COMPONENT DATA HANDLER. The example below illustrates a "RETURN" user response.

```
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.4 CHANGE. The CHANGE command allows the user to change the values of the Vehicle, Enginé, or Transmission data. Most, but not all, values are changeable. As with the other database commands, the user must specify which component he wants to change (i.e., Vehicle, Enginé, or Transmission). A menu of changeable data values for the specified component is displayed at this point. The user is then prompted for the number which corresponds to the value to be changed. The current data value is furnished by the simulation; the simulation then prompts for the new data value, which is also displayed. The user will be allowed to change as many component data values as desired. When all changes for that component have been accomplished, the number which corresponds to the "RETURN" should be entered by the user. For a description of any data item see Section 3.

The following example depicts changing the vehicle's gross weight value:

```
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>VEHICLE
  FOLLOWING IS A LIST OF CHANGEABLE VEHICLE ATTRIBUTES:
     1 = VEHICLE NAME
     2 = DEFAULT ENGINE
     3 = DEFAULT TRANSMISSION
     4 = GROSS VEHICLE WEIGHT (LB)
     5 = ACTIVE TRACK WEIGHT (LBM)
     6 = PRIMARY ROAD ROLLING RESISTANCE (LBF/TON)
     7 = SECONDARY ROAD ROLLING RESISTANCE (LBF/TON)
     8 = CROSS COUNTRY ROLLING RESISTANCE (LBF/TON)
     9 = FRONTAL AREA (FT**2)
    10 = AIR DRAG COEFFICIENT (REAL)
    11 = RETURN
  ENTER THE NUMBER OF YOUR CHOICE
>4
 PRESENT GROSS VEHICLE WEIGHT IS  120000
  ENTER NEW GROSS VEHICLE WEIGHT (LB INTEGER)
>124000
 NEW GROSS VEHICLE WEIGHT IS  124000
  ENTER THE NUMBER OF YOUR CHOICE
>11
```

The next example reflects a change to the engine's installation loss factor:

```
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>ENGINE
 FOLLOWING IS A LIST OF THE CHANGEABLE ENGINE ATTRIBUTES:
     1 = ENGINE NAME
     2 = ENGINE MAXIMUM GROSS HORSEPOWER
     3 = INSTALLATION LOSS FACTOR
     4 = STANDARD TEMPERATURE
     5 = STANDARD ALTITUDE
     6 = RATED ENGINE RPM
     7 = ENGINE IDLE RPM
     8 = ENGINE SPEED FOR SHIFT
     9 = NUMBER OF RPM VS TORQUE OR HORSEPOWER VALUES
         ENGINE RPM VS GROSS TORQUE OR HORSEPOWER
    10 = ACCESSORY POWER LOSS
    11 = ALTERNATOR POWER LOSS
    12 = ENGINE FAN POWER LOSS
    13 = TEMPERATURE LOSS FACTOR
    14 = ALTITUDE LOSS FACTOR
    15 = ENGINE FUEL CONSUMPTION MAP
    16 = RETURN
 ENTER THE NUMBER OF YOUR CHOICE
```

```
>3
 PRESENT INSTALLATION LOSS FACTOR IS 0.97
 ENTER NEW INSTALLATION LOSS FACTOR  (REAL)
>.95
 INSTALLATION LOSS FACTOR IS NOW 0.95
 ENTER THE NUMBER OF YOUR CHOICE
>16
```

The final example illustrates several changes to the transmission data. First, the transmission gear shift time is changed. Next, the list of engines compatible with the transmission is requested by the user and printed by the simulation. The simulation then asks if a compatible engine is to be changed. The user responds affirmatively. After this a menu of changeable transmission engine-dependent values is printed; and the user is prompted for the number of the value to be changed. The user specifies a change to the sprocket pitch radius. This change is accomplished, and the user is prompted for the next transmission engine-dependent value change. There are none, so the user enters the number corresponding to the "RETURN" command (in this case 22), which returns him to the level where additional transmission values can be chang d. No updates are desired; therefore, the number corresponding to the "RETURN" (in this case 6) is entered.

```
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>TRANS
 FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ATTRIBUTES:
    1 = TRANSMISSION NAME
    2 = TRANSMISSION GEAR SHIFT TIME
    3 = TRANSMISSION MOMENT OF INERTIA
    4 = LIST THE COMPATIBLE ENGINES
    5 = CREATE A NEW ENGINE FROM AN EXISTING ONE
    6 = RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>2
 PRESENT TRANSMISSION GEAR SHIFT TIME IS  0.050
  ENTER NEW TRANSMISSION GEAR SHIFT TIME
>.2
 TRANSMISSION GEAR SHIFT TIME IS NOW  0.200
 ENTER THE NUMBER OF YOUR CHOICE
>4
      ENGINE   1  RC4-350.RO
      ENGINE   2  AGT-1500
      ENGINE   3  TWIN-903.1
      ENGINE   4  TWIN-903.2
      ENGINE   5  TWIN-903'S
      ENGINE   6  ONE.903.1
      ENGINE   7  ONE.903.2
      ENGINE   8  ONE.903.3
      ENGINE   9  MTU-871HOT
      ENGINE  10  AVCR-1360
```

```
     ENGINE  11  MACK-E-9
     ENGINE  12  TWIN-903'S
     ENGINE  13  TWIN-E-9'S
     ENGINE  14  TWIN-903.1
     ENGINE  15  TWIN-903.2
     ENGINE  16  ONE.903.1
     ENGINE  17  ONE.903.2
     ENGINE  18  ONE.903.3
     ENGINE  19  RR-CV12HOT
     ENGINE  20  MTU-880HOT
     ENGINE  21  MTU-880CLD
 IS A COMPATIBLE ENGINE TO BE CHANGED YES(Y) OR NO(N)
>YES
 ENTER NUMBER OF ENGINE TO BE CHANGED
>2
  THE FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ENGINE DEPENDENT ATTRIBUTES:
     1 = DEPENDENT ENGINE NAME
     2 = CONVERTER DESIGNATION
     3 = ENGINE TO TRANSMISSION GEAR RATIO AND EFFICIENCY
     4 = TRANSFER CASE GEAR RATIO AND EFFICIENCY
     5 = STARTING GEAR
     6 = TRANSMISSION FAN TORQUE LOSS CURVE COEFFICIENTS
     7 = FINAL DRIVE GEAR RATIO AND EFFICIENCY
     8 = SPROCKET PITCH RADIUS
     9 = FINAL DRIVE MOMENT OF INERTIA
    10 = SPEED RATIO VS TORQUE RATIO CURVE COEFFICIENTS
    11 = SPEED RATIO VS INPUT CAPACITY FACTOR CURVE COEFFICIENTS
    12 = OUTPUT CAPACITY FACTOR VS SPEED RATIO CURVE COEFFICIENTS
    13 = ENGINE SPEED FOR LOCKUP
    14 = SPEED RATIO FOR LOCKUP
    15 = TRANSMISSION GEAR RATIO AND EFFICIENCY
    16 = TRANSMISSION GEAR MOMENT OF INERTIA
    17 = TRANSMISSION GEAR MODE
    18 = TRANSMISSION INPUT TORQUE LOSS CURVE COEFFICIENTS
    19 = TRANSMISSION OUTPUT TORQUE LOSS CURVE COEFFICIENTS
    20 = TRANSMISSION SHIFT SCENARIO DATA
    21 = NUMBER OF GEARS
    22 = RETURN
  ENTER THE NUMBER OF YOUR CHOICE
>8
 PRESENT SPROCKET RADIUS IS                 1.120 FT
 ENTER NEW SPROCKET RADIUS (FT REAL)
>1.30
 NEW SPROCKET RADIUS IS                     1.300 FT
  ENTER THE NUMBER OF YOUR CHOICE
>22
 FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ATTRIBUTES:
    1 = TRANSMISSION NAME
    2 = TRANSMISSION GEAR SHIFT TIME
    3 = TRANSMISSION MOMENT OF INERTIA
    4 = LIST THE COMPATIBLE ENGINES
```

```
    5 = CREATE A NEW ENGINE FROM AN EXISTING ONE
    6 = RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>6
```

At this point, the user can continue making component changes. No changes are desired by the user, so a "RETURN" response is entered.

```
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.5 SAVE. The SAVE command allows the user to save Vehicle, Engine and Transmission data that he has created or changed, on his local files (USER CATALOG). This data can then be recalled during subsequent simulation sessions. When saving Vehicle, Engine, or Transmission data, the name must be different than any name that is presently in the catalog. The simulation will check the name and tell the user if there is an item on the data files with the same name. If this happens, the CHANGE command should be used to enter a new, unique name. The data can then be saved. The following example shows a user invoking the save command. Next, the current vehicle is saved; then the engine is saved. Finally, the transmission is saved.

```
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>SAVE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 THE VEHICLE CALLED M-1         HAS BEEN SAVED ON FILE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 THE ENGINE CALLED AGT-1500   HAS BEEN SAVED ON FILE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 THE TRANSMISSION CALLED X-1100     HAS BEEN SAVED ON FILE
```

When all desired data has been saved, a "RETURN" response should be entered by the user. This is illustrated below.

```
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
```

```
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.6 DELETE. The DELETE command allows the user to delete the current Vehicle, Engine, or Transmission data that is available to the simulation so that other data can be recalled or new data can be created. No data can be permanently deleted once it is in the AMSTA-RG CATALOG or has been saved on your local files (USER CATALOG); it is only deleted as the current data available to the simulation. The following example shows all three PS**2 components being deleted:

```
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 VEHICLE DELETED
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 ENGINE DELETED
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 TRANS DELETED
```

At this point, all deletion requests were made by the user; therefore, the "RETURN" command is entered.

```
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>
```

2.4.1.7 CREATE. The CREATE command allows the user to interactively enter the data which describes a new Vehicle, Engine, or Transmission. See Section 3 for a description of each of the data items. Following is an example of a vehicle being created:

```
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>CREATE
```

```
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
  ENTER THE VEHICLE NAME (<11 CHARACTERS)
>M-1
  ENTER DEFAULT ENGINE (<11 CHARACTERS) (NAME MUST EXIST IN ENGINE FILE)
>AGT-1500
  ENTER DEFAULT TRANSMISSION (<11 CHARACTERS)
 (NAME MUST EXIST IN TRANSMISSION FILE)
>X-1100
  ENTER GROSS VEHICLE WEIGHT (KG INTEGER)
>120000
  ENTER ACTIVE TRACK WEIGHT (LBM INTEGER)
>8944
  ENTER PRIMARY ROAD ROLLING RESISTANCE (LBF/TON INTEGER)
>90
  ENTER SECONDARY ROAD ROLLING RESISTANCE (LBF/TON INTEGER)
>100
  ENTER CROSS COUNTRY ROLLING RESISTANCE (LBF/TON INTEGER)
>180
  ENTER FRONTAL AREA (FT**2 INTEGER)
>80
  ENTER AIR DRAG COEFFICIENT (REAL)
  TRACK VEHICLES HAVE A COEFFICIENT OF ABOUT 1.3
>1.3
```

The following example demonstrates the creation of an engine:

```
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 ENTER THE ENGINE NAME (<11 CHARACTERS)
>AGT-1500
 ENTER THE ENGINE MAXIMUM GROSS HORSEPOWER (INTEGER)
>1500
 ENTER THE INSTALLATION LOSS FACTOR(<=1 REAL)
>.967
 ENTER THE DEFAULT TEMPERATURE (DEG F INTEGER)
>60
 ENTER THE DEFAULT ALTITUDE (FT ABOVE SEA LEVEL INTEGER)
>0
 ENTER THE RATED ENGINE RPM(INTEGER)
>3000
 ENTER THE ENGINE IDLE RPM (INTEGER)
>1000
 ENTER THE ENGINE SPEED FOR SHIFT (INTEGER)
>2950
 ENTER NUMBER OF PAIRS OF RPM VS TORQUE VALUES(INTEGER)
>10
 ENTER (RPM  TORQUE) SEPARATED BY A SPACE (INTEGER)
  FOR PAIR NUMBER   1
```

```
>800  4450
  FOR PAIR NUMBER   2
>1000  4300
  FOR PAIR NUMBER   3
>1200  4150
  FOR PAIR NUMBER   4
>1400  4000
  FOR PAIR NUMBER   5
>1500  3940
  FOR PAIR NUMBER   6
>1600  3850
  FOR PAIR NUMBER   7
>2000  3550
  FOR PAIR NUMBER   8
>2400  3200
  FOR PAIR NUMBER   9
>2800  2790
  FOR PAIR NUMBER  10
>3000  2625
```

See Appendix E on the method for calculating the coefficients for the following items. These items require data in the form of horsepower or torque loss vs engine speed.

```
 ENTER THE ACCESSORY TORQUE LOSS CURVE COEFFICIENTS(REAL)
>0. 0. 0. 0. 0.
 ENTER THE ALTERNATOR HORSEPOWER LOSS AT RATED RPM (INTEGER)
>27
 ENTER THE ENGINE FAN HORSEPOWER LOSS AT RATED RPM (INTEGER)
>100
```

If no data is available that shows the effect of temperature and altitude on engine performance then a one (1) must be entered for the first value and zeros (0) for the other three values of the TEMPERATURE LOSS FACTOR and the ALTITUDE LOSS FACTOR.

```
 ENTER THE TEMPERATURE LOSS FACTOR CURVE COEFFICIENTS(REAL)
>.141861E+00  -.46512E-02 0. 0.
 ENTER THE ALTITUDE LOSS FACTOR CURVE COEFFICIENTS(REAL)
>.1E+01.+ -.32500E-04 0. 0.
 DO YOU HAVE ENGINE FUEL MAP DATA? (YES OR NO)
>NO
```

If there is a data file with fuel consumption data and it was produced by the Fuel Map Program, the data can be read off the file FUEL.MAP.OUT.DATA. (See APPENDIX F on the use of the Fuel Map Program.) Following is an example of specifying that fuel consumption data should be read from a file:

```
 DO YOU HAVE ENGINE FUEL MAP DATA? (YES OR NO)
```

```
>YES
 IS THE FUEL DATA TO BE READ IN FROM A FILE YES(Y) OR NO(N)
>YES
```

Fuel consumption data can also be entered individually. Following is an example of this:

```
 DO YOU HAVE ENGINE FUEL MAP DATA? (YES OR NO)
>YES
 IS THE FUEL DATA TO BE READ IN FROM A FILE YES(Y) OR NO(N)
>NO
 ENTER THE SPEED STEP SIZE FOR FUEL CONSUMPTION (INTEGER)
>300
 ENTER THE HORSEPOWER STEP SIZE FOR FUEL CONSUMPTION (INTEGER)
>100
 ENTER THE NUMBER OF SPEED POINTS IN THE FUEL CONSUMPTION TABLE (INTEGER)
 INCLUDING ZERO
>11
 ENTER NUMBER OF HORSEPOWER POINTS IN FUEL CONSUMPTION TABLE (INTEGER)
 INCLUDING ZERO
>16
 ENTER SPEED(INTEGER), HORSEPOWER(INTEGER) AND FUEL CONSUMPTION (REAL)
 FOR THE ENGINE FUEL CONSUMPTION MAP
 TO END INPUT ENTER ALL ZEROS (0)
 ENTER DATA
>0 0 1.733
 ENTER DATA
>300 100 1.664
 ENTER DATA
>600 200 1.219
 ENTER DATA
>900 300 .912
 ENTER DATA
>0 0 0
```

The next example shows a transmission being created:

```
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 ENTER THE TRANS NAME (<11 CHARACTERS)
>X-1100
 ENTER NUMBER OF TRANSMISSION TYPE-THE TYPES AVAILABLE ARE
    1 = HYDROKINETIC WITH OR WITHOUT LOCKUP
    2 = MECHANICAL
>1
 ENTER GEAR SHIFT TIME (SEC REAL)
>.05
 ENTER TRANSMISSION MOMENT OF INERTIA (REAL FT-LBF-SEC**2)
>3.
```

```
 WHAT IS THE NAME OF THE ENGINE MATCHED TO THIS TRANSMISSION
 (<11 CHARACTERS AND MUST EXIST IN ENGINE FILE)
>AGT-1500
 WHAT IS IT'S CONVERTER DESIGNATION(<11 CHARACTERS)
>TC-897-3B
```

If there is no Engine to Transmission gear or Transfer Case gear then the gear ratio and efficiency are one (1).

```
 ENTER THE ENGINE TO TRANS GEAR RATIO (REAL)
>1.
 ENTER THE ENGINE TO TRANS GEAR EFFICIENCY (REAL)
>1.
 ENTER THE TRANSFER CASE GEAR RATIO (REAL)
>1.
 ENTER THE TRANSFER CASE GEAR EFFICIENCY (REAL)
>1.
```

The Final Drive gear is also the ratio of the Differential in normal automotive applications.

```
 ENTER THE FINAL DRIVE GEAR RATIO (REAL)
>4.3
 ENTER THE FINAL DRIVE GEAR EFFICIENCY (REAL)
>.98
 ENTER THE FINAL DRIVE MOMENT OF INERTIA (FT-LBF/SEC**2 REAL)
>7.52
 ENTER THE SPROCKET RADIUS (FT REAL)
>1.12
 ENTER THE NUMBER OF TRANSMISSION GEARS FOR THIS ENGINE
>4
 ENTER THE STARTING GEAR (INTEGER)
>2
```

The following three items are torque converter characteristics which in most cases cannot be described by only 1 curve. Therefore the data is divided into 2 parts and a curve is fitted to both parts. See Appendix E on the use of GRAFTEK, the curve fitting program. These curves are usually divided at a speed ratio of from .8 to .9. Several trials are usually needed to find the best point to divide this data. The first four data points represent the curve from Ø speed ratio to the change point.

```
 ENTER SPEED RATIO WHERE INPUT CAPACITY FACTOR AND TORQUE RATIO
 CURVES CHANGE (REAL)
>.87
 ENTER THE 8 'OEFFICIENTS (RFAL) FOR SPEED RATIO VS TORQUE RATIO
>.23E+1 -.148E+1 .319541E+Ø -.386Ø9E+Ø
>.717278E+2 -.23Ø19E+3 .249618E+3 -.9Ø2Ø7E+2
 ENTER THE 8 COEFFICIENTS (REAL) FOR SPEED RATIO VS INPUT CAPACITY FACTOR
>.283E+2 29763ØE+2 -.1ØØ4E+3 .1132Ø4E+3
```

```
>-.46522E+5 .156412E+6 -.17531E+6 .655903E+5
 ENTER THE 8 COEFFICIENTS (REAL) FOR OUTPUT CAPACITY FACTOR VS SPEED RATIO
>.572476E-2 .497067E-1 -.10521E-2 .835641E-05
>.487245E+0 .13733E-1 -.1379E-3 .483642E-6
```

The following items which refer to input and output losses for the transmission require data which showes torque loss vs transmission input speed. GRAFTEK is then used to fit curves to this data (See Appendix E). If there is no data enter 0 for all the coefficients.

```
 ENTER THE TRANS FAN TORQUE LOSS CURVE COEFFICIENTS (REAL)
>0. 0. 0. 0.
 ENTER 4 COEFFICIENTS (REAL) FOR TRANS INPUT TORQUE LOSS CURVE-CONVERTER
>.38896E+2 .355505E-1 -.10646E-5 0.
 ENTER 4 COEFFICIENTS (REAL) FOR TRANS INPUT TORQUE LOSS CURVE-LOCKUP
>.38896E+2 .355505E-1 -.10646E-5 0.
 FOR GEAR  1 ENTER THE 4 COEFFICIENTS (REAL)
 FOR THE TRANS OUTPUT TORQUE LOSS
>.370579E+2 .327095E-1 .114288E-5 .280044E-9
 FOR GEAR  2 ENTER THE 4 COEFFICIENTS (REAL)
 FOR THE TRANS OUTPUT TORQUE LOSS
>.489163E+2 .400539E-1 -.15701E-4 .455355E-8
 FOR GEAR  3 ENTER THE 4 COEFFICIENTS (REAL)
 FOR THE TRANS OUTPUT TORQUE LOSS
>.818664E+2 .256677E-1 -.19742E-4 .630666E-8
 FOR GEAR  4 ENTER THE 4 COEFFICIENTS (REAL)
 FOR THE TRANS OUTPUT TORQUE LOSS
>.970775E+2 .977782E-2 -.17140E-5 .426055E-8
 ENTER THE TRANSMISSION GEAR MODE FOR EACH GEAR (INTEGER)
 (CONVERTER ONLY=1, LOCKUP ONLY=2 OR BOTH=3)
 FOR GEAR  1
>1
 FOR GEAR  2
>3
 FOR GEAR  3
>3
 FOR GEAR  4
>3
 ENTER THE CONVERTER SPEED RATIO FOR LOCKUP FOR EACH GEAR (REAL)
 FOR GEAR  1
>.86
 FOR GEAR  2
>.86
 FOR GEAR  3
>.86
 FOR GEAR  4
>.86
 ENTER THE TRANSMISSION GEAR RATIO FOR EACH GEAR (REAL)
 FOR GEAR  1
>5.88
 FOR GEAR  2
```

```
>3.02
 FOR GEAR  3
>1.89
 FOR GEAR  4
>1.28
 ENTER THE TRANSMISSION GEAR EFFICIENCY FOR EACH GEAR (REAL)
 FOR GEAR  1
>.94
 FOR GEAR  2
>.94
 FOR GEAR  3
>.94
 FOR GEAR  4
>.95
 ENTER THE TRANSMISSION GEAR MOMENT OF INERTIA FOR EACH GEAR (REAL)
 FOR GEAR  1
>110.
 FOR GEAR  2
>25.
 FOR GEAR  3
>13.
 FOR GEAR  4
>10.
```

The TRANSMISSION SHIFT SCENARIO is the normal sequence that the transmission will use during acceleration.

```
 ENTER TRANSMISSION SHIFT SCENARIO FOR EACH GEAR CONDITION
 A 1 INCLUDES THE CONDITION, A 0 EXCLUDES THE CONDITION
 FOR GEAR 1CONVERTER AND LOCKUP
>0 0
 FOR GEAR 2CONVERTER AND LOCKUP
>1 1
 FOR GEAR 3CONVERTER AND LOCKUP
>0 1
 FOR GEAR 4CONVERTER AND LOCKUP
>0 1
```

This data is required only for those gear conditions in the shift scenario all oter data is 0.

```
 ENTER 4 TRANSMISSION SHIFT LINE HORSEPOWER AND VEHICLE SPEED POINTS
 ONLY FOR THOSE CONDITIONS IN THE SCENARIO
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 1 CONVERTER
>0 0 0 0 0 0 0 0
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 1 LOCKUP
>0 0 0 0 0 0 0 0
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 2 CONVERTER
>0 6.5 275 6.5 950 10.5 950 10.5
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 2 LOCKUP
>0 12 175 12 700 18 1000 18
```

```
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 3 CONVERTER
>0 0 0 0 0 0 0 0
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 3 LOCKUP
>0 19 175 19 700 28 1000 28
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 4 CONVERTER
>0 0 0 0 0 0 0 0
 ENTER THE 4 PAIRS OF HORSEPOWER AND SPEED VALUES FOR GEAR 4 LOCKUP
>0 45 950 45 950 45 950 45
```

When you have completed creating the desired components, a "RETURN" or "RET" should be entered. This will return you to the COMPONENT DATA HANDLER level.

```
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)    ENGINE(E)    TRANS(T)    RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)    LIST(L)    CHANGE(CH)    SAVE(S)
  RECALL(R)    DELETE(D)    QUERY(Q)    RETURN(RET)
>
```

2.4.1.8 RETURN. The RETURN command transfers simulation control to the next higher level. In other words, it causes the simulation to terminate the database operations. The following example demonstrates a "RETURN" response to the COMPONENT DATA HANDLER. This causes simulation control to be transferred to the TOP LEVEL CONTROLLER.

```
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)    LIST(L)    CHANGE(CH)    SAVE(S)
  RECALL(R)    DELETE(D)    QUERY(Q)    RETURN(RET)
>RETURN
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)    SIMULATE(SIM)    GRAPH(G)    OR    STOP(S)
>
```

2.4.2 SIMULATE COMMAND. The SIMULATE command allows the user to perform different types of analysis on the Vehicle, Engine, and Transmission data. The user must make sure that the engine and transmission have been properly matched. (See APPENDIX G for further information). Following is an example of the SIMULATE command. The user is prompted for a concept title; it will be used by the simulation to label any graphs. Next a menu of available simulation options is presented, and the user is prompted to enter his choice.

```
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)    SIMULATE(SIM)    GRAPH(G)    OR    STOP(S)
>SIMULATE
 ENTER CONCEPT TITLE (WHICH WILL APPEAR ON GRAPHS)
 (10 CHARACTERS OR LESS WITH NO BLANKS)
```

```
>TEST
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>
```

2.4.2.1 FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED. The Full Throttle Tractive Force vs Speed simulation calculates the amount of force available at the ground for selected vehicle speeds. This information is necessary to determine grade performance and is also necessary to run the Full Power Acceleration and Fuel Consumption simulations.

Following is an example of a user requesting a full throttle tractive force vs vehicle speed simulation. The simulation presents the default temperature and altitude which it will use and prompts the user for any changes. The simulation is performed, and the user menu is printed by the simulation.

```
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>1
 TRACTIVE.FORCE.DATA DOES NOT EXIST.  IT WILL BE CREATED.
 IN ROUTINE TO FIND TRACTIVE FORCE VS SPEED
 OUTPUT LISTING WILL BE ON THE FILE TRACTIVE.FORCE.DATA
 THE AMBIENT TEMPERATURE IS   60 DEG F  THE ALTITUDE IS    0 FT
 DO YOU WANT TO CHANGE THESE VALUES  YES(Y) OR NO(N)
>NO
 THE TRACTIVE FORCE VS SPEED SIMULATION IS COMPLETE
 OUTPUT FILE IS TRACTIVE.FORCE.DATA
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>
```

The following example is the same as the preceding example. The only difference is that the user had already requested a full throttle tractive force vs vehicle speed simulation during this terminal session. The prior request caused a TRACTIVE.FORCE.DATA file to be created, and its disposition must be addressed before another simulation can be

performed. This example demonstrates a user trying to continue; however, the simulation will not allow this. The file must either be saved, spooled (routed to a printer), or deleted.

```
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>1
DO YOU WANT TO (1)SAVE, (2)SPOOL, (3)DELETE OR (4)CONTINUE
THE PRESENT TRACTIVE.FORCE.DATA FILE
>4
THE PRESENT TRACTIVE.FORCE.DATA FILE WAS NOT OPENED
IT CAN NOT BE CONTINUED
DO YOU WANT TO (1)SAVE, (2)SPOOL, (3)DELETE OR (4)CONTINUE
THE PRESENT TRACTIVE.FORCE.DATA FILE
>3
IN ROUTINE TO FIND TRACTIVE FORCE VS SPEED
OUTPUT LISTING WILL BE ON THE FILE TRACTIVE.FORCE.DATA
THE AMBIENT TEMPERATURE IS   60 DEG F  THE ALTITUDE IS    0 FT
DO YOU WANT TO CHANGE THESE VALUES  YES(Y) OR NO(N)
>N
THE TRACTIVE FORCE VS SPEED SIMULATION IS COMPLETE
OUTPUT FILE IS TRACTIVE.FORCE.DATA
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>
```

2.4.2.2 FULL POWER ACCELERATION PERFORMANCE. This simulation is used to predict the vehicle full power acceleration performance for Vehicle Speed vs Time (e.g., time from 0-10 MPH and 0-20 MPH) and Distance vs Time (e.g., time from 0-500 FT). The user can also make disposition of the ACCEL.DATA file here. Additionally, there are two items that the user can select that will affect the acceleration simulation. The first is the Rolling Resistance, which determines the type of terrain being traversed; and the second is the traction coefficient, which represents the capability of the surface to provide traction.

Following is an example of the dialog required to compute a full power acceleration performance simulation. As in the above example, a previous simulation of this type had been performed; therefore, the output file disposition must be addressed. At this point the user is prompted for the rolling resistance to be used; next the simulation presents the traction coefficient and prompts for any desired changes.

The requested simulation is performed, and the user is prompted for his next choice.

```
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>2
 DO YOU WANT TO, 1(SAVE), 2(SPOOL), 3(DELETE) OR 4(CONTINUE)
 THE PRESENT ACCEL.DATA FILE ?
3
  OUTPUT DATA WILL BE ON THE FILE CALLED ACCEL.DATA
 IN ROUTINE TO SIMULATE FULL POWER ACCELERATION
  SET THE ROLLING RESISTANCE
 1 = PRIMARY ROAD ROLLING RESISTANCE IS    90 LB/TON
 2 = SECONDARY ROAD ROLLING RESISTANCE IS 100 LB/TON
 3 = CROSS COUNTRY ROLLING RESISTANCE IS  180 LB/TON
 4 = OTHER AS DESIRED
>1
 THE TRACTION COEFFICIENT IS 0.75
 DO YOU WANT TO CHANGE THE TRACTION COEFFICIENT YES(Y) OR NO(N)
>NO
  ENTER ACCELERATION ROUTINE
 INITIALIZE DATA
 M-1        AGT-1500  X-1100
  AVERAGE SPROCKET HP     1054.67     FOR TOP SPEED OF     43.5871
 THE FULL POWER ACCELERATION SIMULATION IS COMPLETE
 OUTPUT FILE IS ACCEL.DATA
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>
```

2.4.2.3 FUEL CONSUMPTION. This simulation produces a vehicle fuel map showing lines of constant MPG. The map can be used to make fuel consumption predictions for various scenarios where the vehicle load conditions are known. The FUEL CONSUMPTION option has a large number of calculations and may take from 5 to 10 minutes depending on the number of gear conditions of the Transmission. The user can also make disposition of the FUEL.DATA file here.

Following is an example of a fuel consumption simulation. Again, a fuel consumption simulation had already been performed, so the user is prompted for the existing file disposition. The fuel consumption simulation is performed, and the user is prompted for his next simulation facility choice.

```
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>3
DO YOU WANT TO (1)SAVE, (2)SPOOL, (3)DELETE OR (4)CONTINUE
THE PRESENT FUEL.DATA FILE
>3
CALCULATING MILEAGE
WRITING DATA TO OUTPUT FILE
THE FUEL CONSUMPTION SIMULATION IS COMPLETE
OUTPUT FILE IS FUEL.DATA
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>
```

2.4.2.4 RETURN TO TOP LEVEL CONTROLLER. Selection of this choice returns the user to the TOP LEVEL CONTROLLER level of the simulation. The following example illustrates this choice:

```
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>4
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>
```

2.4.3 GRAPH COMMAND. The GRAPH command provides the user with the opportunity to obtain graphical output of the results of the simulations. If the Tektronix terminal is used, a hard copy of all selected graphs can be made. Each available graph is presented in the following sections. An example of the computer prompt is as follows:

```
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>GRAPH
GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
   1 = TRACTIVE FORCE VS VEHICLE SPEED
```

```
    2 = ACCELERATION DISTANCE VS TIME
    3 = ACCELERATION VEHICLE SPEED VS TIME
    4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
    5 = FUEL CONSUMPTION IN CONSTANT MPG
    6 = RETURN TO TOP LEVEL CONTROLLER
 ENTER NUMBER
>
```

If you are trying to obtain a graph on a terminal which does not have graphical capabilities (a TTY type 1), a message similar to the following will be printed, and you will be returned to the TOP LEVEL CONTROLLER.

```
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>GRAPH
 THE TERMINAL TYPE YOU ENTERED (1) DOES NOT HAVE GRAPHING CAPABILITIES
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>
```

If your terminal has graphical capabilities, the following graphs can be drawn.

2.4.3.1 TRACTIVE FORCE VS SPEED GRAPH. The graph of Tractive Force (LB) vs Vehicle Speed (MPH) shows the Tractive Force for every possible gear condition. Also presented on this graph are lines which show the Tractive Force requirements for grades of 0% slope, 10% slope and 60% slope. Figure 2-1 is a sample TRACTIVE FORCE VS SPEED GRAPH.

```
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>G
 GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
 NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
 AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
    1 = TRACTIVE FORCE VS VEHICLE SPEED
    2 = ACCELERATION DISTANCE VS TIME
    3 = ACCELERATION VEHICLE SPEED VS TIME
    4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
    5 = FUEL CONSUMPTION IN CONSTANT MPG
    6 = RETURN TO TOP LEVEL CONTROLLER
 ENTER NUMBER
>1
 IN ROUTINE TO DRAW TRACTIVE FORCE VS SPEED
  SET THE ROLLING RESISTANCE
 1 = PRIMARY ROAD ROLLING RESISTANCE IS     90 LB/TON
 2 = SECONDARY ROAD ROLLING RESISTANCE IS 100 LB/TON
 3 = CROSS COUNTRY ROLLING RESISTANCE IS  180 LB/TON
 4 = OTHER AS DESIRED
>1
```

TRACTIVE FORCE VS SPEED

CONCEPT: TEST — M-1
ROLLING RESIS.(LB/TON): 90.
ENGINE: AGT-1500
TRANSMISSION: X-1100
FRONTAL AREA: 80.

GROSS ENGINE HP: 1500.
AT RPM: 3000.
GVW: 120000.
FINAL DRIVE RATIO: 4.300

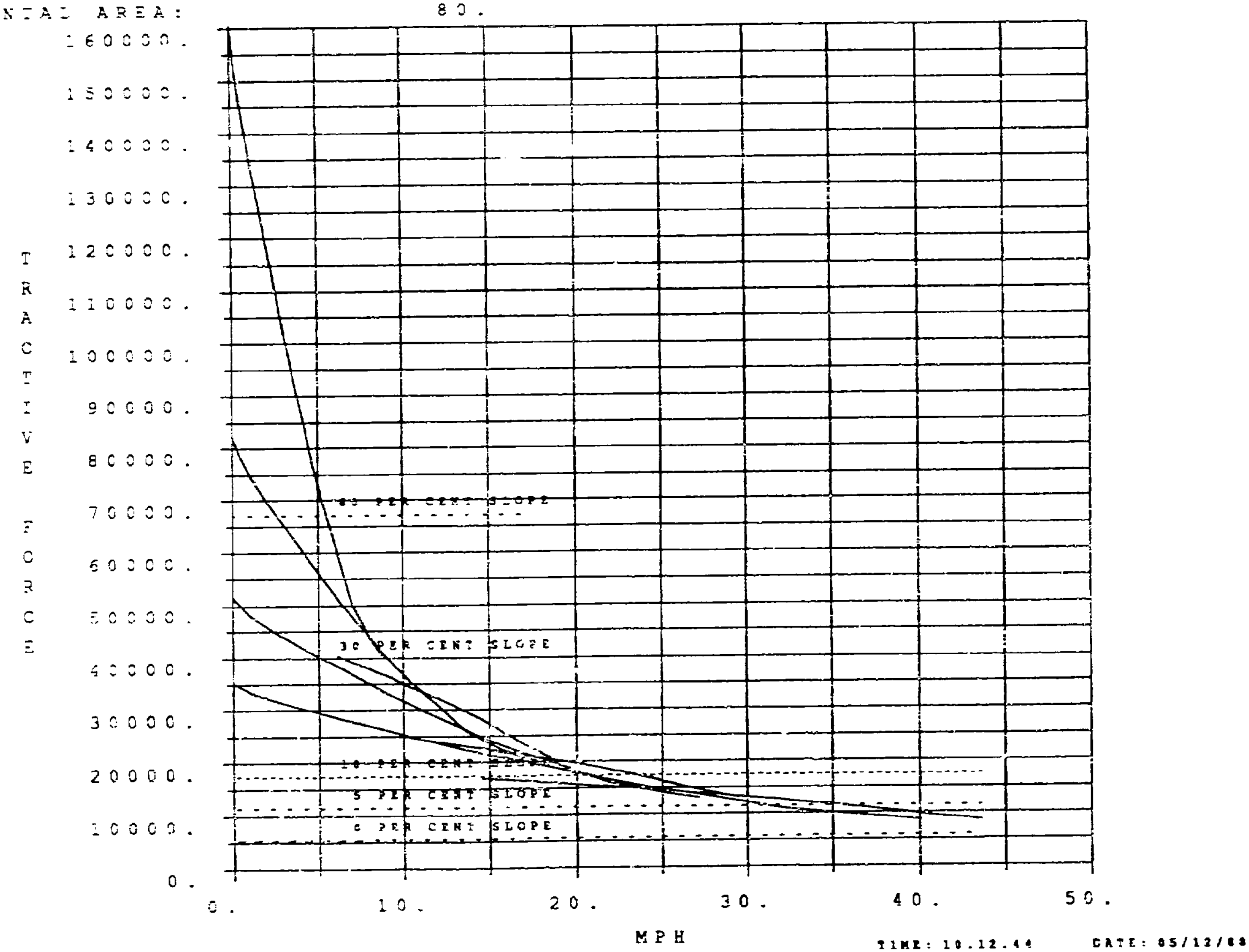


Figure 2-1. Tractive Force vs Speed Graph

2.4.3.2 DISTANCE VS TIME GRAPH. This graph shows the Distance (FT) vs Time (SEC) and is used to determine the time for 0-500 FT. Figure 2-2 is a sample of a DISTANCE VS TIME GRAPH.

```
GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
    1 = TRACTIVE FORCE VS VEHICLE SPEED
    2 = ACCELERATION DISTANCE VS TIME
    3 = ACCELERATION VEHICLE SPEED VS TIME
    4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
    5 = FUEL CONSUMPTION IN CONSTANT MPG
    6 = RETURN TO TOP LEVEL CONTROLLER
ENTER NUMBER
>2
IN ROUTINE TO DRAW DISTANCE VS TIME
```

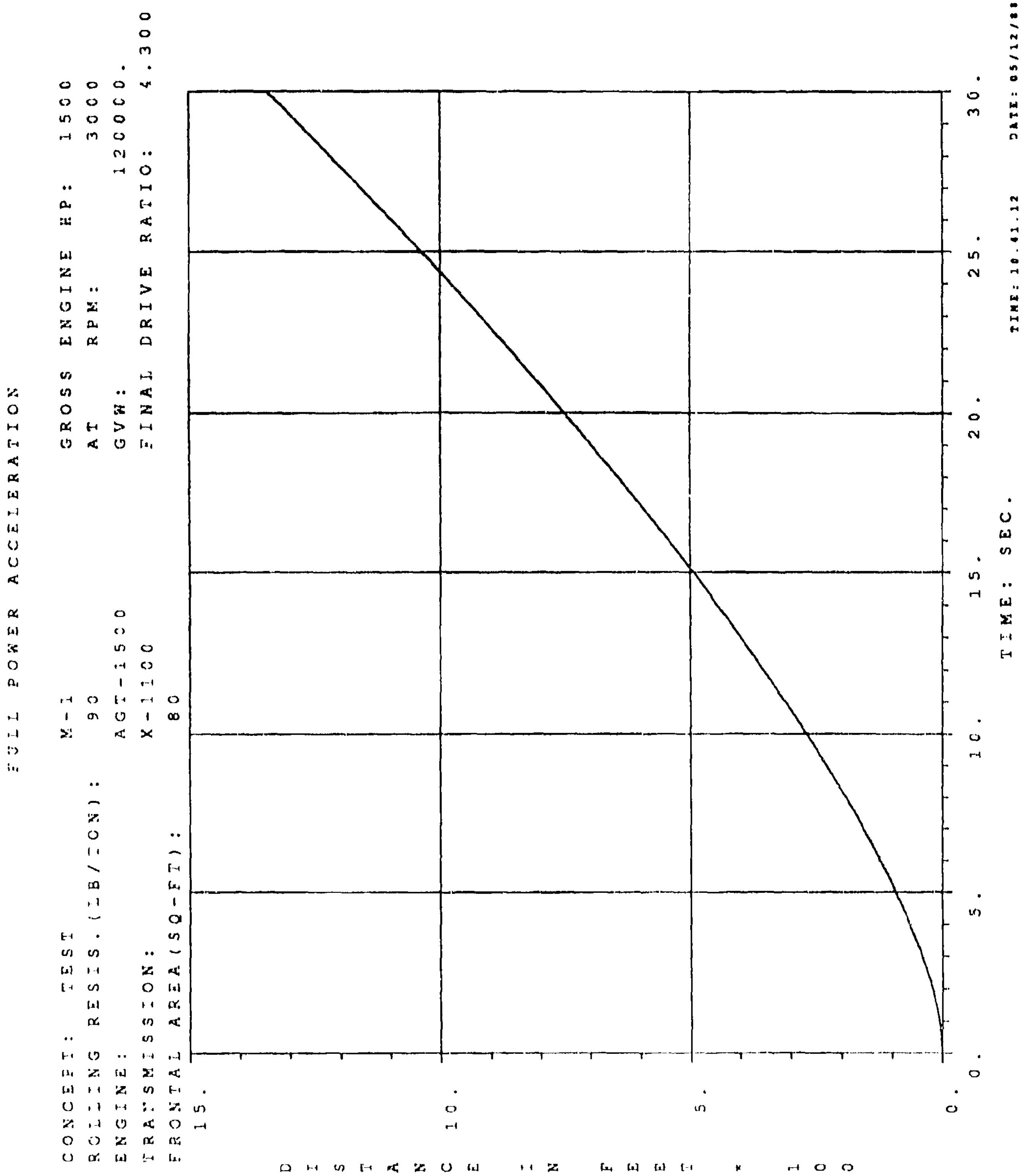


Figure 2-2. Distance vs. Time Graph

2.4.3.3 SPEED VS TIME GRAPH. This graph shows the Vehicle Speed (MPH) vs Time (SEC) and is used to determine the times for 0-10 MPH and 0-20 MPH. Figure 2-3 is a sample of a SPEED VS TIME GRAPH.

```
GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
   1 = TRACTIVE FORCE VS VEHICLE SPEED
   2 = ACCELERATION DISTANCE VS TIME
   3 = ACCELERATION VEHICLE SPEED VS TIME
   4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
   5 = FUEL CONSUMPTION IN CONSTANT MPG
   6 = RETURN TO TOP LEVEL CONTROLLER
ENTER NUMBER
>3
IN ROUTINE TO DRAW SPEED VS TIME
```

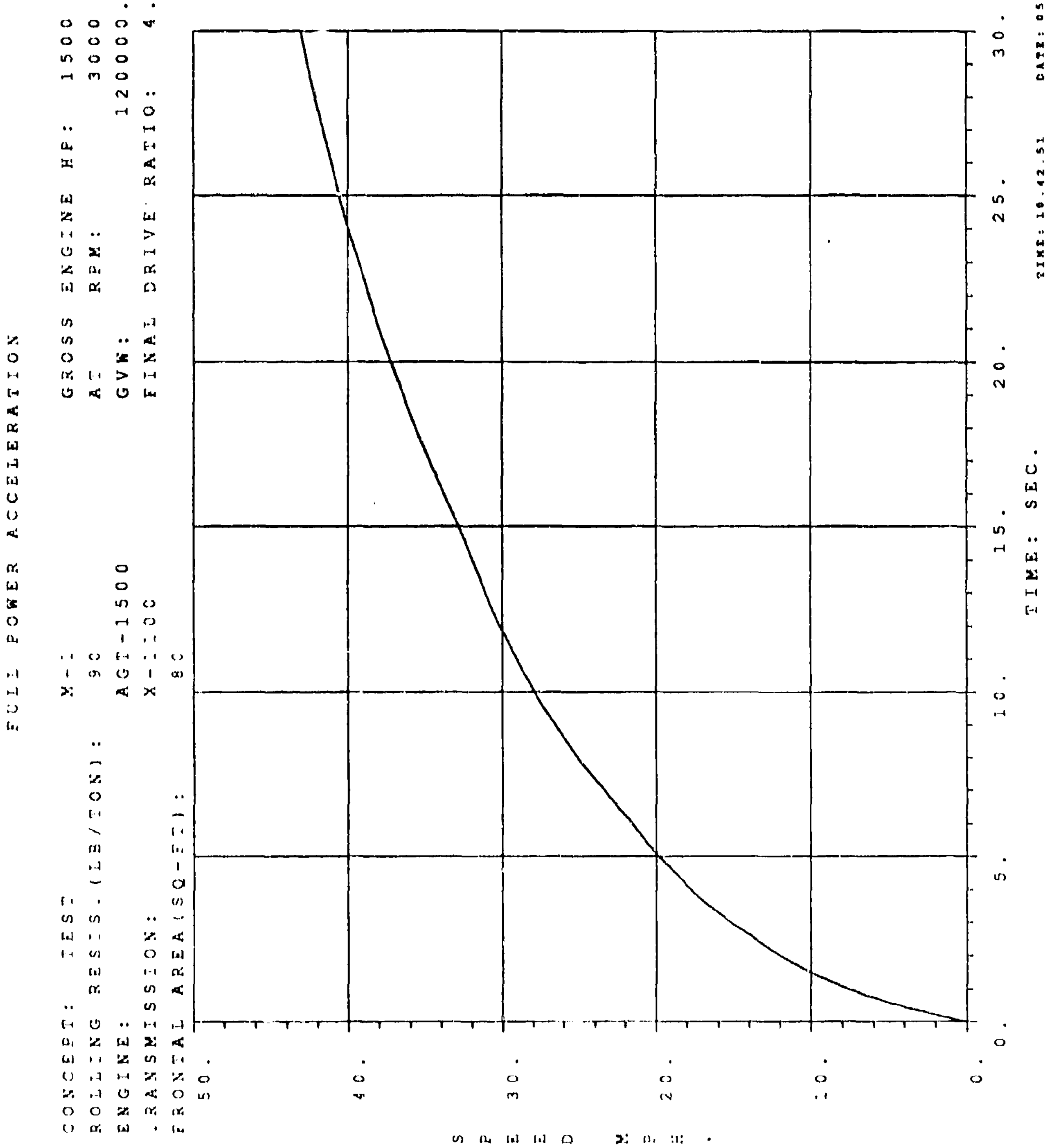


Figure 2-3. Speed vs Time Graph

2.4.3.4 SPROCKET HORSEPOWER VS SPEED GRAPH. The graph of Sprocket Horsepower vs Vehicle Speed (MPH) shows every possible gear condition. Also presented on the graph are lines which show the Sprocket Horsepower requirements for grades of 0% slope, 10% slope and 60% slope. The grade lines show the effect of wind resistance as well. Figure 2-4 is a sample of a SPROCKET HORSEPOWER VS SPEED GRAPH.

```
 GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
 NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
 AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
    1 = TRACTIVE FORCE VS VEHICLE SPEED
    2 = ACCELERATION DISTANCE VS TIME
    3 = ACCELERATION VEHICLE SPEED VS TIME
    4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
    5 = FUEL CONSUMPTION IN CONSTANT MPG
    6 = RETURN TO TOP LEVEL CONTROLLER
 ENTER NUMBER
>4
  SET THE ROLLING RESISTANCE HORSEPOWER VS SPEED!!!!!
 1 = PRIMARY ROAD ROLLING RESISTANCE IS    90 LB/TON
 2 = SECONDARY ROAD ROLLING RESISTANCE IS 100 LB/TON
 3 = CROSS COUNTRY ROLLING RESISTANCE IS  180 LB/TON
 4 = OTHER AS DESIRED
>1
```

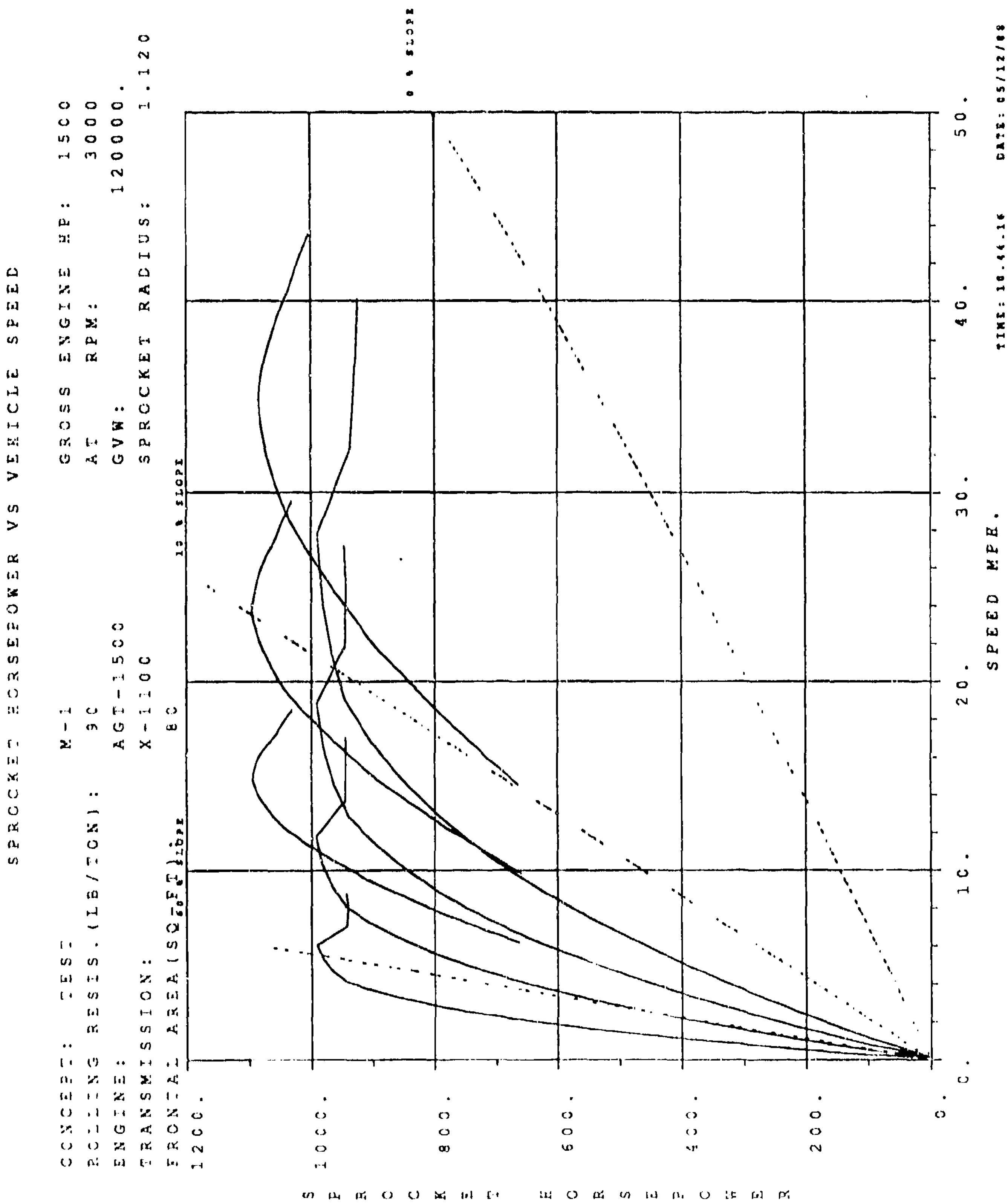


Figure 2-4. Sprocket Horsepower vs Speed Graph

2.4.3.5 FUEL CONSUMPTION LINES OF CONSTANT MILES PER GALLON. The graphs of Fuel Consumption are plots of Sprocket Horsepower vs Vehicle Speed for every possible gear condition. On each plot are lines of constant Miles per Gallon. Figure 2-5 is a sample of a FUEL CONSUMPTION LINES OF CONSTANT MILES PER GALLON.

```
 GRAPHING FACILITY:  THE FOLLOWING GRAPHS CAN BE DRAWN
 NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
 AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
    1 = TRACTIVE FORCE VS VEHICLE SPEED
    2 = ACCELERATION DISTANCE VS TIME
    3 = ACCELERATION VEHICLE SPEED VS TIME
    4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
    5 = FUEL CONSUMPTION IN CONSTANT MPG
    6 = RETURN TO TOP LEVEL CONTROLLER
 ENTER NUMBER
>5
 IN ROUTINE TO DRAW FUEL CONSUMPTION CHART
```

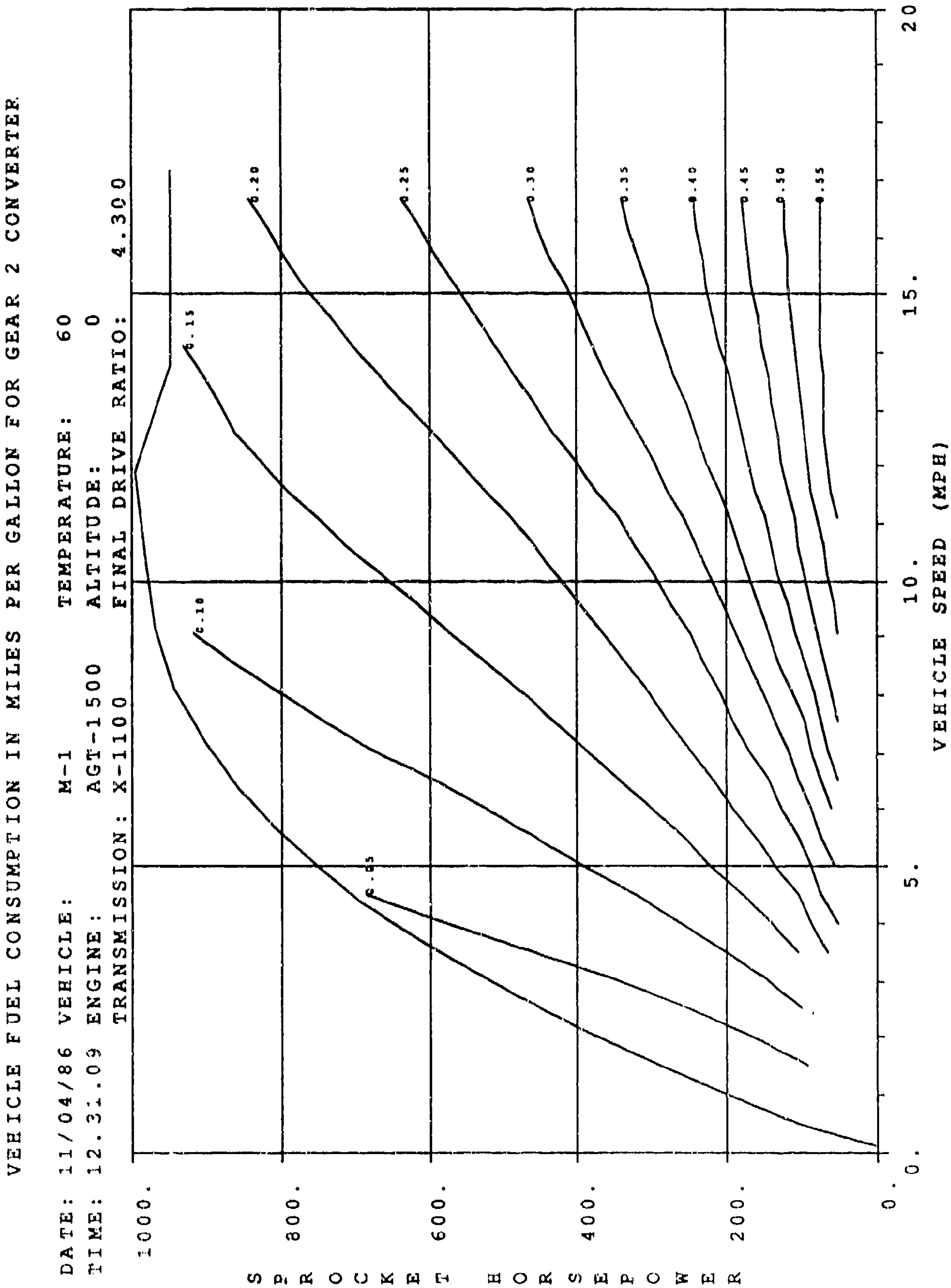


Figure 2-5. Fuel Consumption Graph

2.4.3.6 RETURN. This choice returns the user to the TOP LEVEL CONTROLLER level of the simulation. The following example illustrates this choice:

```
GRAPHING FACILITY: THE FOLLOWING GRAPHS CAN BE DRAWN
NOTE!! AFTER A SELECTED GRAPH HAS BEEN DRAWN (I.E., THE DATE
AND TIME ARE PRINTED), ENTER A CARRIAGE RETURN TO CONTINUE
   1 = TRACTIVE FORCE VS VEHICLE SPEED
   2 = ACCELERATION DISTANCE VS TIME
   3 = ACCELERATION VEHICLE SPEED VS TIME
   4 = SPROCKET HORSEPOWER VS VEHICLE SPEED
   5 = FUEL CONSUMPTION IN CONSTANT MPG
   6 = RETURN TO TOP LEVEL CONTROLLER
ENTER NUMBER
>6
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>
```

2.4.4 STOP COMMAND. The STOP command ends execution of the simulation and returns the user to PRIMOS Operating System level. At this time the user can look at the output files using the ED command in PRIMOS, use the SPOOL command and list the files at a printer, or logout from the computer.

```
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>STOP
IF SIMULATIONS HAVE BEEN RUN THE FOLLOWING FILES CONTAIN OUTPUT DATA:
   TRACTIVE FORCE VS SPEED ON TRACTIVE.FORCE.DATA
   FULL POWER ACCELERATION ON ACCEL.DATA
   FUEL CONSUMPTION ON FUEL.DATA
OK,
```

2.5 TERMINATING THE TERMINAL SESSION (LOGOUT). After entering the STOP command, indicating that you have finished using the PS**2, the computer will respond with "OK,". The terminal session is completed by typing the PRIMOS "LOGOUT" command. The computer will print some summary information; you can then turn off the terminal (and the modem, if you were using one). If you were using a dataphone, pick up the receiver, depress the DATA button, and then hang up the phone. It is a good practice to check for a dial tone at this point.

3.Ø SIMULATION INPUTS

This section gives a description of each of the input data items.

3.1 VEHICLE

3.1.1 VEHICLE DATA ITEM DESCRIPTIONS

VEHICLE NAME: (TEXT) 1Ø unique characters or less

DEFAULT ENGINE: (TEXT) 1Ø unique characters or less, must exist on ENGINE.DATA file

DEFAULT TRANSMISSION: (TEXT) 1Ø unique characters or less, must exist on TRANS.DATA file

GROSS VEHICLE WEIGHT: (LB INTEGER)

ACTIVE TRACK WEIGHT: (LB INTEGER) Weight of track not on the ground

PRIMARY ROAD ROLLING RESISTANCE: (LB/TON INTEGER) Resistance to motion on hard surface. Wheeled vehicles are approximately 3Ø LB/TON and tracked vehicles range from 7Ø to 1ØØ LB/TON.

SECONDARY ROAD ROLLING RESISTANCE: (LB/TON INTEGER) Resistance to motion on loose surface. This resistance is approximately 1Ø% greater than Primary Road Resistance.

CROSS COUNTRY ROLLING RESISTANCE: (LB/TON INTEGER) Resistance to motion off road. This resistance is approximately 1ØØ% greater than Primary Road Resistance.

FRONTAL AREA: (FT**2 INTEGER) Frontal cross-sectional area.

AIR DRAG COEFFICIENT: (REAL) Coefficient used to calculate wind resistance, trucks and tanks have a coefficient of from .8 to 1.5.

3.1.2 VEHICLE DATA SHEET

The next page shows a filled-in VEHICLE DATA SHEET.

VEHICLE DATA SHEET

VEHICLE NAME	= M-1	
DEFAULT ENGINE	= AGT-1500	
DEFAULT TRANSMISSION	= X-1100	
GROSS VEHICLE WEIGHT	= 120000	LB

This is the weight of the track that is not on the ground.

ACTIVE TRACK WEIGHT	= 8944	LB

Rolling resistance for wheeled vehicles on hard surface is around 30 lb/ton. Army tracked vehicles are generally 3 times this amount. Secondary road rolling resistance is approximately 10% greater and cross country rolling resistance is about 100% greater.

PRIMARY ROAD ROLLING RESISTANCE	= 90	LB/TON
SECONDARY ROAD ROLLING RESISTANCE	= 100	LB/TON
CROSS COUNTRY ROLLING RESISTANCE	= 180	LB/TON
FRONTAL AREA	= 80	FT**2

Air drag coefficients of different vehicles are as follows:

Trucks	.8 to 1.5
Van body	.5 to .7
Car	.3 to .5

AIR DRAG COEFFICIENT = 1.3

3.2 ENGINE

3.2.1 ENGINE DATA ITEM DESCRIPTION

ENGINE NAME: 10 unique characters or less (TEXT)

ENGINE MAXIMUM HORSEPOWER: Maximum rated gross horsepower (HP INTEGER)

INSTALLATION LOSS FACTOR: Fraction of gross power available due to installation losses (REAL)

STANDARD TEMPERATURE: Ambient temperature for net power calculations (DEG F INTEGER)

STANDARD ALTITUDE: Altitude for net power calculations (FT INTEGER)

RATED ENGINE RPM: Maximum manufacturer rpm rating (RPM INTEGER)

ENGINE IDLE RPM: Engine idle rpm (RPM INTEGER)

ENGINE SPEED FOR SHIFT: Engine speed for transmission shifting (RPM INTEGER)

ENGINE RPM VS GROSS TORQUE: Gross torque vs rpm data (FT-LB INTEGER RPM INTEGER)

COEFFICIENTS TO ENGINE ACCESSORY TORQUE LOSS CURVE: These are coefficients to a third order polynomial equation that fit the accessory torque loss vs rpm data. (REAL)

COEFFICIENTS TO ENGINE ALTERNATOR TORQUE LOSS CURVE: These are coefficients to a third order polynomial equation that fit the alternator torque loss vs rpm data. (REAL)

COEFFICIENTS TO ENGINE FAN TORQUE LOSS CURVE: These are coefficients to a third order polynomial equation that fit the engine fan torque loss vs rpm data. (REAL)

COEFFICIENTS TO AMBIENT TEMPERATURE VS PERFORMANCE LOSS DATA: These are coefficients to a third order polynomial equation that fit the ambient temperature vs power reduction data. (REAL)

COEFFICIENTS TO ENGINE TORQUE LOSS DUE TO ALTITUDE DATA: These are coefficients to a third order polynomial equation that fit the altitude vs power reduction data. (REAL)

FUEL CONSUMPTION HORSEPOWER STEP SIZE: This is the horsepower step used for engine fuel map data. (HP INTEGER)

FUEL CONSUMPTION ENGINE SPEED STEP SIZE: This is the engine rpm step used for engine fuel map data. (RPM INTEGER)

NUMBER OF ENGINE RPM POINTS INCLUDING ZERO: This is the number of steps starting with Ø and ending with rated engine speed. (INTEGER)

NUMBER OF HORSEPOWER POINTS INCLUDING ZERO: This is the number of steps starting with Ø and ending with rated engine horsepower. (INTEGER)

ENGINE FUEL CONSUMPTION: The engine fuel map data is in BSFC in LB/HP-HR; there is a value for each combination of speed and horsepower. This is necessary in order for the simulation to make interpolations near the full power line. (LB/HP-HR REAL)

3.2.2 ENGINE DATA SHEET

The next 2 pages show a filled-in ENGINE DATA SHEET.

ENGINE DATA SHEET
(PAGE 1)

ENGINE NAME	= AGT-1500	
ENGINE MAXIMUM HORSEPOWER	= 1500	HP
INSTALLATION LOSS FACTOR LESS THAN OR EQUAL TO 1.000	= 0.967	
STANDARD TEMPERATURE	= 60	DEG F
STANDARD ALTITUDE	= 0	FT
RATED ENGINE RPM	= 3000	RPM
ENGINE IDLE RPM	= 1000	RPM
ENGINE SPEED FOR SHIFT	= 2950	RPM
ENGINE MOMENT OF INERTIA	= 6.5	FT-LB-SEC**2

ENGINE RPM VS CROSS TORQUE

RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF
800	4450	1000	4300	1200	4150	1400	4000
1500	3940	1600	3850	2000	3550	2400	3200
2800	2790	3000	2625				

The following engine data is fitted to third order polynomial equations. In order to find the coefficients the program GRAFTEK can be used. See Appendix E on the use of this program.

COEFFICIENTS TO ENGINE TORQUE LOSS CURVES

	CONSTANT	X	X**2	X**3
ACCESSORY	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
ALTERNATOR	0.115280E+03	-0.23415E-01	0.000000E+00	0.000000E+00
ENGINE FAN	0.000000E+00	0.145049E-02	0.186072E-04	0.150022E-09

COEFFICIENTS TO TEMPERATURE AND ALTITUDE CORRECTION FACTOR CURVES

TEMPERATURE	0.141861E+01	0.46512E-02	0.000000E+00	0.000000E+00
ALTITUDE	0.100000E+01	-0.32500E-04	0.000000E+00	0.000000E+00

ENGINE DATA SHEET
(PAGE 2)

The data in the engine fuel consumption map must be filled out completely in order for the simulation to operate properly. Data values are in BSFC (lb/hp-hr). Data outside the full power curve and at the zero points on the axis is developed by straight line extrapolation. There is a program available to digitize an engine fuel map and put that data into the correct format for this simulation, Appendix F describes the use of this program and the required inputs.

FUEL CONSUMPTION ENGINE SPEED STEP SIZE = 300
FUEL CONSUMPTION HORSEPOWER STEP SIZE = 100
NUMBER OF ENGINE RPM POINTS INCLUDING ZERO = 11
NUMBER OF HORSEPOWER POINTS INCLUDING ZERO = 16

SAMPLE ENGINE FUEL CONSUMPTION MAP

SPROCKET HORSEPOWER \ ENGINE RPM	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
1500	1.406	1.258	1.109	0.961	0.812	0.664	0.604	0.565	0.522	0.503	0.500
1400	1.302	1.172	1.043	0.914	0.784	0.655	0.593	0.546	0.507	0.487	0.480
1300	1.197	1.087	0.976	0.866	0.756	0.646	0.581	0.529	0.492	0.479	0.475
1200	1.092	1.001	0.910	0.819	0.728	0.637	0.569	0.514	0.489	0.477	0.475
1100	0.987	0.915	0.843	0.772	0.700	0.628	0.553	0.513	0.490	0.482	0.480
1000	1.055	0.968	0.881	0.794	0.707	0.620	0.544	0.517	0.497	0.492	0.490
900	1.281	1.136	0.991	0.846	0.700	0.616	0.555	0.522	0.507	0.502	0.503
800	1.304	1.151	0.998	0.845	0.692	0.613	0.561	0.535	0.520	0.515	0.520
700	1.248	1.109	0.970	0.830	0.683	0.612	0.575	0.547	0.537	0.535	0.541
600	1.217	1.089	0.962	0.834	0.701	0.628	0.589	0.570	0.556	0.562	0.571
500	1.185	1.069	0.954	0.838	0.707	0.644	0.606	0.595	0.587	0.594	0.610
400	1.424	1.240	1.056	0.872	0.740	0.669	0.637	0.633	0.630	0.640	0.667
300	2.259	1.634	1.000	0.912	0.773	0.700	0.687	0.687	0.700	0.725	0.760
200	2.084	1.649	1.219	0.985	0.833	0.783	0.780	0.800	0.850	0.900	0.950
100	1.908	1.664	1.438	1.114	1.000	1.000	1.142	1.190	1.285	1.427	1.456
0	1.733	1.680	1.658	1.684	1.950	1.950	1.855	2.140	1.998	2.140	2.026

3.3 TRANSMISSION

3.3.1 TRANSMISSION DATA ITEM DESCRIPTIONS

TRANSMISSION NAME: 10 unique characters or less (TEXT)

TRANSMISSION TYPE: There are presently 2 types of transmissions that can be simulated; they are (1) Hydrokinetic and (2) Mechanical (INTEGER)

TRANSMISSION GEAR SHIFT TIME: The time delay between gear shifts (SEC REAL), usually less than 1 second.

TRANSMISSION MOMENT OF INERTIA: Polar moment of inertia of the rotating components (FT-LB-SEC**2 REAL)

NAME OF ENGINE MATCHED TO THIS TRANSMISSION: 10 characters or less, must exist on ENGINE.DATA file (TEXT)

IF TRANS TYPE=HYDROKINETIC, CONVERTER NAME: 10 characters or less (TEXT)

ENGINE TO TRANSMISSION GEAR RATIO: (REAL)

ENGINE TO TRANSMISSION GEAR EFFICIENCY: (REAL)

TRANSFER CASE GEAR RATIO: (REAL)

TRANSFER CASE GEAR EFFICIENCY: (REAL)

FINAL DRIVE GEAR RATIO: (REAL)

FINAL DRIVE GEAR EFFICIENCY: (REAL)

SPROCKET PITCH RADIUS: FT (REAL)

NUMBER OF GEARS: (INTEGER) Maximum of 6

NORMAL STARTING GEAR: (INTEGER)

The following items are curves of data which have been fitted with third order polynomial equations. The first three items, which deal with the operational characteristics of the torque converter of a Hydrokinetic type of transmission, have been fitted with 2 curves.

SPEED RATIO AT WHICH THE CURVES CHANGE: (REAL)

COEFFICIENTS TO THE TWO SPEED RATIO VS TORQUE RATIO CURVES: 8 VALUES (REAL)

COEFFICIENTS TO THE TWO SPEED RATIO VS INPUT CAPACITY FACTOR CURVES: 8

VALUES (REAL)

COEFFICIENTS TO THE TWO OUTPUT CAPACITY FACTOR VS SPEED RATIO CURVES: 8 VALUES (REAL)

The next items deal with transmission losses and are fitted with only 1 curve.

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE CONVERTER: 4 VALUES (REAL)

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE LOCKUP: 4 VALUES (REAL)

COEFFICIENTS FOR TRANS OUTPUT TORQUE LOSS CURVE: 4 VALUES For each gear (REAL)

TRANSMISSION GEAR MODE: This indicates for the hydrokinetic type of transmission if the particular gear operates in (1) converter only, (2) lockup only, or (3) both converter and lockup. One for each gear (INTEGER)

CONVERTER SPEED RATIO FOR LOCKUP: One for each gear (REAL)

TRANSMISSION GEAR RATIO: One for each gear (REAL)

TRANSMISSION GEAR EFFICIENCY: One for each gear (REAL)

TRANSMISSION GEAR MOMENT OF INERTIA: One for each gear (REAL)

TRANSMISSION SHIFT SCENARIO: This indicates if a gear condition occurs in normal acceleration. A 1 means that the gear condition occurs, a 0 means that it does not. Two for each gear (INTEGER)

TRANSMISSION GEAR SHIFT VALUES: Four pairs are required for every gear condition (both Converter and Lockup) in the shift scenario.

3.3.2 TRANSMISSION DATA SHEET

The next 4 page show a filld in TRANSMISSION DATA SHEET.

TRANSMISSION DATA SHEET
(PAGE 1)

TRANSMISSION NAME	= X-1100	
TRANSMISSION TYPE	= HYDROKINETIC MECHANICAL	X
TRANSMISSION GEAR SHIFT TIME	= 0.05	SEC
TRANSMISSION INPUT MOMENT OF INERTIA	= 3.000	FT-LB-SEC**2
NAME OF ENGINE MATCHED TO THIS TRANSMISSION	= AGT-1500	
IF TYPE=HYDROKINETIC, CONVERTER NAME	= TC-897-3B	
ENGINE TO TRANSMISSION GEAR RATIO	= 1.000	
ENGINE TO TRANSMISSION GEAR EFFICIENCY	= 1.000	
TRANSFER CASE GEAR RATIO	= 1.000	
TRANSFER CASE GEAR EFFICIENCY	= 1.000	
FINAL DRIVE GEAR RATIO	= 4.300	
FINAL DRIVE GEAR EFFICIENCY	= 0.980	
FINAL DRIVE MOMENT OF INERTIA	= 7.520	FT-LB-SEC**2
SPROCKET PITCH RADIUS	= 1.120	FT
NUMBER OF GEARS	= 4	
NORMAL STARTING GEAR	= 2	

TRANSMISSION DATA SHEET
(PAGE 2)

The next three items are the torque converter characteristics of a hydrokinetic type transmission. This data is fitted with third order polynomial equations. In order to find the coefficients the program GRAFTEK can be used. See Appendix E on the use of this program.

The data can be fitted to either 1 or 2 curves. If one curve is used then the speed ratio at which the curves change must be 1.0 and the coefficients for curve 2 are set to zero. If 2 curves are used then all three data items must change at the same speed ratio.

SPEED RATIO AT WHICH THE CURVES CHANGE = .870

COEFFICIENTS TO THE TWO SPEED RATIO VS TORQUE RATIO CURVES

	CONSTANT	X	X**2	X**3
CURVE 1	0.230000E+01	-0.14800E+01	0.319541E+00	-0.38609E+00
CURVE 2	0.717278E+02	-0.23019E+03	0.249618E+03	-0.90207E+02

COEFFICIENTS TO THE TWO SPEED RATIO VS INPUT CAPACITY FACTOR CURVES

CURVE 1	0.283000E+02	0.297630E+02	-0.10040E+03	0.113204E+03
CURVE 2	-0.46522E+05	0.156412E+06	-0.17531E+06	0.655903E+05

COEFFICIENTS TO THE TWO OUTPUT CAPACITY FACTOR VS SPEED RATIO CURVES

CURVE 1	0.5?2476E-02	0.497067E-01	-0.10521E-02	0.835641E-05
CURVE 2	0.487245E+00	0.137330E-01	-0.13790E-03	0.483642E-06

TRANSMISSION FAN TORQUE LOSS COEFFICIENTS

	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE

CONVERTER	0.388960E+02	0.355505E-01	-0.10646E-05	0.000000E+00
LOCKUP	0.388960E+02	0.355505E-01	-0.10646E-05	0.000000E+00

COEFFICIENTS FOR TRANS OUTPUT TORQUE LOSS CURVE

GEAR	CONSTANT	X	X**2	X**3
1	0.370579E+02	0.327095E-01	0.114288E-05	0.280044E-09
2	0.489163E+02	0.400539E-01	-0.15701E-04	0.455355E-08
3	0.818664E+02	0.256677E-01	-0.19742E-04	0.630666E-08
4	0.970775E+02	0.977782E-02	-0.17140E-05	0.426055E-08
5	______	______	______	______
6	______	______	______	______

TRANSMISSION DATA SHEET
(PAGE 3)

The following data items require 1 entry for each gear ratio. The simulation can accept transmissions with up to 6(six) gear ratios.

The transmission'GEAR MODE represents the capability of a hydrokinetic type transmission. The modes are:

TRANSMISSION GEAR MODE = 1 (CONVERTER ONLY)
= 2 (LOCKUP ONLY)
= 3 (BOTH CONVERTER AND LOCKUP)

When the transmission type is MECHANICAL then the TRANSMISSION'GEAR MODE must be 2 for every gear.

TRANSMISSION'GEAR MODE	1 = 1 2 = 3 3 = 3 4 = 3 5 = ____ 6 = ____
CONVERTER SPEED RATIO FOR LOCKUP	1 = .86 2 = .86 3 = .86 4 = .86 5 = ____ 6 = ____
TRANSMISSION'GEAR RATIO	1 = 5.880 2 = 3.020 3 = 1.890 4 = 1.280 5 = ____ 6 = ____
TRANSMISSION'GEAR EFFICIENCY	1 = .940 2 = .940 3 = .940 4 = .950 5 = ____ 6 = ____
TRANS'GEAR OUTPUT MOMENT'OF INERTIA	1 = 110. 2 = 25. 3 = 13. 4 = 10. 5 = ____ 6 = ____

TRANSMISSION DATA SHEET
(PAGE 4)

The following data is used in the fuel consumption simulation. The TRANSMISSION SHIFT SCENARIO is the normal gear shifting sequence when the vehicle is accelerating or decelerating. The TRANSMISSION GEAR SHIFT VALUES represent a shift line for a particular gear condition; these are sets of horsepower and vehicle speed values, across which the transmission will shift to the next gear in the TRANSMISSION SHIFT SCENARIO. There will only be TRANSMISSION GEAR SHIFT VALUES for the conditions which have a 1 in the TRANSMISSION SHIFT SCENARIO.

TRANSMISSION SHIFT SCENARIO

GEAR	CONVERTER	LOCKUP
1	0	0
2	1	1
3	0	1
4	0	1
5	0	0
6	0	0

TRANSMISSION GEAR SHIFT VALUES

CONVERTER

GEAR	1		2		3		4		5		6	
ITEM	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
1			0.	6.5								
2			275.	6.5								
3			950.	10.5								
4			950.	10.5								

LOCKUP

GEAR	1		2		3		4		5		6	
ITEM	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
1			0.	12.0	0.	19.0	0.	45.0				
2			175.	12.0	175.	19.0	950.	45.0				
3			700.	17.5	700.	28.0	950.	45.0				
4			1025.	17.5	1000.	28.0	950.	45.0				

4.Ø SIMULATION OUTPUTS

4.1 GRAPHICAL

Currently, the PS**2 provides five types of graphical output. These are as follows:

- o Tractive Force vs Speed
- o Distance vs Time
- o Speed vs Time
- o Sprocket Horsepower vs Speed
- o Lines of Constant Miles per Gallon on Sprocket Horsepower vs Speed

See Section 2.4.3 for a description and example of each graph.

4.2 TABULAR

Currently, PS**2 provides three types of tabular output. Each is explained in more detail in the following three sections.

4.2.1 TRACTIVE.FORCE.DATA FILE. The TRACTIVE.FORCE.DATA file lists the concept information and all input data for the engine and transmission. The output consists of data for all the engine losses and a list of the tractive force, sprocket horsepower and speed for each gear range for converter mode and for lockup mode. The transmission heat rejection for first gear range is also listed.

4.2.2 ACCEL.DATA FILE. The ACCEL.DATA file contains some identifying information about the Vehicle, Engine, and Transmission, a list of the tractive force vs speed data used to calculate the acceleration, and a list of acceleration data at .Ø1 sec intervals. The information in this list consists of the time, gear, equivalent weight used to calculate acceleration, total resistance at the present speed, total tractive force available, acceleration at the present speed (MPH), distance (FT), sprocket horsepower, mass factor, and change in acceleration. The mass factor represents the gross vehicle weight plus the effect of the inertia of rotating components divided by the gross vehicle weight.

4.2.3 FUEL.DATA FILE

The fuel.data file contains a list of the input data for the vehicle, engine, and transmission. The output consists of a list of the fuel consumption in MPG for every gear condition, sprocket horsepower step, and vehicle speed step. There is also a list of speed and sprocket horsepower data for the constant mileage lines for each gear condition.

5.Ø ERROR HANDLING

5.1 ERRORS THAT ARE EASILY REMEDIED

Mode/Data errors are the most common type of error that will be encountered. The error will appear when the wrong type/mode of data has been entered or commas have been used to separate a list of numbers. When this happens the following message will appear:

> SIMSCRIPT-W-ERROR 2Ø84, invalid character in "I" format during input
> Do you want traceback?(YES, NO or PRINT)

The answer to this should be "NO," after which the following will appear:

> "Input rest of line starting from the erroneous field:"

Now the correct data can be entered, and the simulation will continue executing.

5.2 ERRORS THAT CAUSE SIMULATION EXECUTION TO TERMINATE

When an error is encountered that causes the simulation to terminate the following message will appear:

> SIMSCRIPT-F-ERROR XXXX, (a comment of what kind of error was encountered.) Do you want traceback?(YES, NO or PRINT)

A "YES" will cause the traceback to print immediately at the terminal; a "NO" will give no traceback. "PRINT" will put the traceback on the file SIMUØ6.LIST. The traceback will show where the error occurred and list other information about the simulation. The most common problem that may cause the simulation to terminate is a mismatch between the engine and the transmission.

Any time you encounter a SIMSCRIPT error, which causes simulation execution to terminate, it is important to obtain a hardcopy of the traceback. This can be accomplished by responding to the traceback prompt with "PRINT" and spooling the SIMUØ6.LIST file to a printer, or responding "YES" and copying the contents of the screen with a copying device. Either way, take the traceback to the Time Share Computer Branch (AMSTA-RYT) when assistance is needed in determining the cause of simulation termination.

APPENDIX A

TEKTRONIX TERMINAL INFORMATION

The important keys on this terminal are: 1) the TTY LOCK, located at the lower left of the keyboard, which will make the terminal type in all caps, 2) the BACKSPACE, located at the upper right of the keyboard, which is the character delete, 3) and the RUBOUT key, located just to the right of the CARRIAGE RETURN, which is the line delete key. If the need arises to stop the terminal from printing, pressing the CONTROL(CTRL) key and the "S" simultaneously will halt the terminal; to continue press "CONTROL Q".

APPENDIX B

TAB TERMINAL INFORMATION

The important keys on this terminal are: 1) the LOCK, located at the lower left of the keyboard, which will make the terminal type in all caps when the red light is on, 2) the BACKSPACE, located at the upper right of the keyboard, which is the character delete, 3) and the DELETE, located just to the right of the RETURN, which is the line delete key. On the TAB terminal the listing may be stopped by pressing the HOLD key an the lower left hand of the keyboard; to continue press the key a second time.

APPENDIX C

DECWRITER (TTY) TERMINAL INFORMATION

The important keys on this terminal are: 1) the CAPS LOCK, located at the lower left of the keyboard, which will make the terminal type in all caps, 2) the BACK SPACE, located at the upper right of the keyboard, which is the character delete, and 3) the DELETE key, located just to the right of the RETURN, which is the line delete key.

APPENDIX D

SAMPLE TERMINAL SESSION

The following is a sample of a terminal session using the Engine Transmission Performance Evaluation Program.

```
OK, SEG JACOBSON>PERFORMANCE>PS**2

 WELCOME TO THE PROPULSION SYSTEM PERFORMANCE SIMULATION.
 SIMULATION EXECUTION WAS INITIATED AT 09.57.14   ON 12/20/83  .
 IF YOU HAVE ANY DIFFICULTIES USING THIS SIMULATION, CONTACT
 RICHARD JACOBSON AT EXT. 45879/45999

 IT IS NECESSARY FOR YOU, THE USER, TO PROVIDE SOME INFORMATION
 SO THAT THE SIMULATION CAN TAILOR INPUTS AND OUTPUTS FOR YOU.
 ENTER YOUR RESPONSES FOLLOWING THE ">", AND MAKE SURE THEY
 ARE IN UPPERCASE.  IT IS ALSO NECESSARY TO DEPRESS THE "RETURN" KEY
 TO TRANSMIT YOUR RESPONES TO THE COMPUTER.
 ENTER THE BAUD RATE IN CHARACTERS PER SECOND (120 OR 960)
>960
 ENTER TERMINAL TYPE
    1 = TTY
    2 = TEKTRONIX 4014
    3 = RAMTEK 6211
    4 = TAB 132/C
 IF YOU ARE UNSURE OR YOUR TERMINAL TYPE IS NOT LISTED, ENTER 1
 ENTER NUMBER
>1
 FOR YOUR CONVENIENCE, THIS SIMULATION CONTAINS A SYSTEM OF
 "PROMPTS" WHICH PROVIDE/REQUEST INFORMATION. THE PROMPT LEVEL IS
 CURRENTLY SET TO PROVIDE THE MAXIMUM AMOUNT OF INFORMATION.  UNTIL
 YOU BECOME PROFICIENT IN THE USE OF THIS SIMULATION, WE RECOMMEND NOT
 CHANGING THE LEVEL OF PROMPTING PROVIDED.
 DO YOU WANT TO CHANGE THE PROMPT LEVEL?  ENTER YES(Y) OR NO(N)
>NO
 ENTER USER ID
>XXYYZZ
 THIS SIMULATION HAS THE CAPABILITY OF CALCULATING THE TRACTIVE
 FORCE VS VEHICLE SPEED OF AN ENGINE DRIVELINE SYSTEM AND EVALUATING
 THE FULL POWER ACCELERATION AND FUEL CONSUMPTION OF A VEHICLE SYSTEM.
 THE LIST THAT FOLLOWS THIS MESSAGE SHOWS THE AVAILABLE VEHICLES
 (WITH THEIR DEFAULT ENGINES AND TRANSMISSIONS)
 AND OTHER AVAILABLE ENGINES AND TRANSMISSIONS.  NOT ALL COMBINATIONS
 OF ENGINES AND TRANSMISSIONS ARE POSSIBLE.  THE ENGINES THAT HAVE
 BEEN MATCHED WITH A PARTICULAR TRANSMISSION ARE INCLUDED IN THE
 TRANSMISSION DATA.  THERE ARE TWO TYPES OF OUTPUT WITH THIS SIMULATION.
 GRAPHS CAN BE GENERATED WITH THE GRAPH OPTION AND NUMERICAL DATA
 IS OUTPUT TO FILES.  NUMERICAL OUTPUT FOR TRACTIVE FORCE VS SPEED
 IS WRITTEN TO THE FILE TRACTIVE.FORCE.DATA AND THE FULL POWER ACCELERATION
 DATA, AT 0.1 SEC INTERVALS, IS WRITTEN TO THE FILE ACCEL.DATA.
 FUEL CONSUMPTION DATA IN MILES PER GALLON IS WRITTEN ON THE FILE FUEL.DATA.
```

A LIST OF VEHICLES, ENGINES AND TRANSMISSIONS WILL BE LISTED BY ENTERING A CARRIAGE RETURN.

DO YOU WANT TO SEE THE AMSTA-RG CATALOG ? YES(Y) OR NO(N)
>YES

AMSTA-RG CATALOGED DATA

VEHICLE WITH ENGINE AND TRANSMISSION			ENGINES	TRANSMISSIONS
M-60	AVDS-1790	CD-850-6A	RC4-350.RO	TX-100-1A
M-48	AVDS-1790	CD-850	6V53	X-1100
M-113-ITV	6V53	TX-100-1A	AGT-1500	X-300W/OTC
M113-A1	6V53	TX-100-1A	MTU-871HOT	X-300
XM-1	AGT-1500	X-1100	MTU-880CLD	RENK-304
M-1	AGT-1500	X-1100	RR-CV12HOT	AMX-1000
XM-723.TB	RC2.350TCB	X-300.RC2E	GT-601	AMX-NO.TC
M-48.A5	AVDS-1790	CD-850	GT-601.MKI	X-300.RC
DIVADS	AVDS-1790	CD-850	GT-601.MIF	CD-850-6A
M-60.A3	AVDS-1790	CD-850-6A	ADIA.4CYL	HMMWV.GMHY
M-60.AX.A	AVDS-1790	CD-850-6A	ADIA.6CYL	X-250
M-60.AX.B	AVDS-1790A	CD-850-6A	ADIA.8CYL	ATT-464
M-60.AX.C	AVDS-1790A	CD-850-6A	LCR.903.8	NP435
LVTP7	RC2-350.65	X-300.RC2E	GT-601.800	X-XXXX
M-1.62	NONE	NONE	RC2.350TC	X-200
HMMWV.GM	HMMWV.GM62	HMMWV.GMHY	RC2.350TCA	
MPG.TEST	GT-601	X-250	GT-601.MIB	
HSTVL	AVCO-650	X-300	AVCR-1790	
RAM	318	NP435	V-903.800	
M-XXX	AGT-1500	X-1100	V-903.80.1	
M-1.1	AGT-1500	X-1100	RC2.350TCB	
			(more not shown)	

DO YOU WANT TO RECALL A VEHICLE, ENGINE OR TRANSMISSION AT THIS TIME
YES(Y) OR NO(N)
>YES
DO YOU WANT DATA FROM THE AMSTA-RG CATALOG YES(Y) OR NO(N)
>YES
RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
VEHICLE(V) ENGINE(E) TRANS(T) RETURN(RET)
>VEHICLE
ENTER THE VEHICLE NAME
>M-1
THE VEHICLE M-1 WAS LOADED FROM THE FILE
RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
VEHICLE(V) ENGINE(E) TRANS(T) RETURN(RET)
ENGINE
DO YOU WANT THE VEHICLE DEFAULT ENGINE LOADED YES(Y) OR NO(N)
>YES
THE ENGINE AGT-1500 WAS LOADED FROM THE FILE
RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
VEHICLE(V) ENGINE(E) TRANS(T) RETURN(RET)

```
>TRANS
 DO YOU WANT THE VEHICLE DEFAULT TRANSMISSION LOADED YES(Y) OR NO(N)
>YES
 THE TRANSMISSION X-1100     HAS BEEN LOADED
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>DATABASE
 DATABASE HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>CREATE
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 A VEHICLE ALREADY EXISTS
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 AN ENGINE ALREADY EXISTS
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 A TRANS ALREADY EXISTS
 CREATE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 DATABASE HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>LIST
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
   VEHICLE NAME                              = M-1
   DEFAULT ENGINE                            = AGT-1500
   DEFAULT TRANSMISSION                      = X-1100
   GROSS VEHICLE WEIGHT                      = 120000      LB
   PRIMARY ROAD ROLLING RESISTANCE           =      90     LB/TON
   SECONDARY ROAD ROLLING RESISTANCE         =     100     LB/TON
   CROSS COUNTRY ROLLING RESISTANCE          =     180     LB/TON
   FRONTAL AREA                              =      80     FT**2
   AIR DRAG COEFFICIENT                      =       1.300
   ACTIVE TRACK WEIGHT                       =    8944     LB

 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 ENGINE NAME = AGT-1500
```

ENG MAX GROSS HP	=	1500	HP
ISTAL LOSS FACTOR	=	0.967	
STD TEMPERATURE	=	60	DEG F
ALTITUDE	=	0	FT
RATED ENG RPM	=	3000	RPM
ENG IDLE RPM	=	1000	RPM
ENG SPEED FOR SHIFT	=	2950	RPM

ENGINE RPM VS GROSS TORQUE MATRIX

RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF
800	4450	1000	4300	1200	4150	1400	4000
1500	3940	1600	3850	2000	3550	2400	3200
2800	2790	3000	2625				

COEFF'S TO TEMP AND ALTITUDE CORRECTION FACTOR CURVES

	CONSTANT	X	X**2	X**3
TEMP	0.141861E+01	-0.46512E-02	0.000000E+00	0.000000E+00
ALTITUDE	0.100000E+01	-0.32500E-04	0.000000E+00	0.000000E+00

ALTITUDE CORRECTION OF FULL POWER	TEMPERATURE	TEMPERATURE CORRECTION	
100	0	100	60
97	1000	100	70
93	2000	100	80
90	3000	100	90
87	4000	95	100
84	5000	91	110
80	6000	86	120
77	7000	81	130
74	8000	77	140
71	9000	72	150

COEFFICIENTS TO ENGINE TORQUE LOSS CURVES

	CONSTANT	X	X**2	X**3
ACC	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
ALT	0.115280E+03	-0.23415E-01	0.000000E+00	0.000000E+00
ENG FAN	0.000000E+00	0.145049E-02	0.186072E-04	0.150022E-09

ACCESSORY RPM	TQ	ALTERNATOR RPM	TQ	ENGINE FAN RPM	TQ
400	0	400	111	400	1
600	0	600	106	600	4
800	0	800	101	800	8
1000	0	1000	97	1000	13
1200	0	1200	92	1200	20
1400	0	1400	87	1400	29
1600	0	1600	82	1600	39
1800	0	1800	78	1800	51

2000	0	2000	73	2000	64
2200	0	2200	68	2200	79
2400	0	2400	64	2400	95
2600	0	2600	59	2600	113
2800	0	2800	54	2800	132
3000	0	3000	50	3000	153
3200	0	3200	45	3200	176

FUEL CONSUMPTION HORSEPOWER STEP SIZE IS 100
FUEL CONSUMPTION SPEED STEP SIZE IS 300

ENGINE FUEL CONSUMPTION MAP

1500	1.41	1.26	1.11	0.96	0.81	0.66	0.60	0.56	0.52	0.50	0.50
1400	1.30	1.17	1.04	0.91	0.78	0.66	0.59	0.55	0.51	0.49	0.48
1300	1.20	1.09	0.98	0.87	0.76	0.65	0.58	0.53	0.49	0.48	0.48
1200	1.09	1.00	0.91	0.82	0.73	0.64	0.57	0.51	0.49	0.48	0.48
1100	0.99	0.92	0.84	0.77	0.70	0.63	0.55	0.51	0.49	0.48	0.48
1000	1.06	0.97	0.88	0.79	0.71	0.62	0.54	0.52	0.50	0.49	0.49
900	1.28	1.14	0.99	0.85	0.70	0.62	0.56	0.52	0.51	0.50	0.50
800	1.30	1.15	1.00	0.84	0.69	0.61	0.56	0.53	0.52	0.52	0.52
700	1.25	1.11	0.97	0.83	0.68	0.61	0.58	0.55	0.54	0.53	0.54
600	1.22	1.09	0.96	0.83	0.70	0.63	0.59	0.57	0.56	0.56	0.57
500	1.19	1.07	0.95	0.84	0.71	0.64	0.61	0.59	0.59	0.59	0.61
400	1.42	1.24	1.06	0.87	0.74	0.67	0.64	0.63	0.63	0.64	0.67
300	2.26	1.63	1.00	0.91	0.77	0.70	0.69	0.69	0.70	0.72	0.76
200	2.08	1.65	1.22	0.98	0.83	0.78	0.78	0.80	0.85	0.90	0.95
100	1.91	1.66	1.44	1.11	1.00	1.00	1.14	1.19	1.28	1.43	1.46
0	1.73	1.68	1.66	1.68	1.95	1.95	1.85	2.14	2.00	2.14	2.03
	0	300	600	900	1200	1500	1800	2100	2400	2700	3000

ENGINE HORSEPOWER VS ENGINE RPM

LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
VEHICLE(V) ENGINE(E) TRANS(T) RETURN(RET)
>TRANS
DATA FOR TRANSMISSION X-1100
WHICH HAS BEEN MATCHED WITH THE FOLLOWING ENGINES

NUMBER	ENGINE NAME
1	RC4-350.RO
2	AGT-1500
3	TWIN-903.1
4	TWIN-903.2
5	TWIN-903'S
6	ONE.903.1
7	ONE.903.2
8	ONE.903.3
9	MTU-871HOT
10	AVCR-1360
11	MACK-E-9

```
   12    TWIN-903'S
   13    TWIN-E-9'S
   14    TWIN-903.1
   15    TWIN-903.2
   16    ONE.903.1
   17    ONE.903.2
   18    ONE.903.3
   19    RR-CV12HOT
   20    MTU-880HOT
   21    MTU-880CLD
   22  TO RETURN
 ENTER NUMBER TO LIST DATA OR RETURN
>2
 TRANS NAME = X-1100     HYDROKINETIC    WITH TC-897-3B CONVERTER

   TRANSMISSION GEAR SHIFT TIME       =     0.05  SEC
   TRANSMISSION MOMENT OF INERTIA     =     3.000 FT-LB-SEC**2

 DATA FOR AGT-1500   ENGINE

   ENGINE TO TRANS GEAR RATIO AND EFFICIENC=       1.000    1.000
   TRANSFER CASE GEAR RATIO AND EFFICIENCY =       1.000    1.000
   FINAL DRIVE GEAR RATIO AND EFFICIENCY   =       4.300    0.980
   FINAL DRIVE MOMENT OF INERTIA           =       7.520 FT-LBF SEC**2
   SPROCKET PITCH RADIUS                   =       1.120 FT
   NUMBER OF GEARS =    4    STARTING GEAR    =  2

             ENGINE  SPEED                   TRANS
             SPEED   RATIO   TRANS   TRANS   GEAR
              FOR     FOR    GEAR    GEAR    MNT OF
   GEAR MODE LOCKUP  LOCKUP   EFF    RATIO   INERTIA
     1   1    2900   0.860   0.940   5.880  110.00
     2   3    2900   0.860   0.940   3.020  25.000
     3   3    2900   0.860   0.940   1.890  13.000
     4   3    2900   0.860   0.950   1.280  10.000

    0.870 IS THE SPEED RATIO AT WHICH THE
    INPUT CAPACITY FACTOR AND TORQUE RATIO
    CURVES CHANGE

   COEFFS TO THE TWO SPEED RATIO VS TORQUE RATIO CURVES
   CONSTANT              X            X**2          X**3
 CURVE 1 0.230000E+01 -0.14800E+01 0.319541E+00 -0.38609E+00
 CURVE 2 0.717278E+02 -0.23019E+03 0.249618E+03 -0.90207E+02

   COEFFS TO THE TWO SPEED RATIO VS INPUT CAPACITY FACTOR CURVES
 CURVE 1 0.283000E+02   0.297630E+02   -0.10040E+03   0.113204E+03
 CURVE 2 -0.46522E+05   0.156412E+06   -0.17531E+06   0.655903E+05

   COEFFS TO THE TWO SPEED RATIO VS OUTPUT CAPACITY FACTOR CURVES
 CURVE 1 0.572476E-02   0.497067E-01   -0.10521E-02   0.835641E-05
```

CURVE 2 0.487245E+00 0.137330E-01 -0.13790E-03 0.483642E-06

SPEED RATIO	TORQUE RATIO	INPUT CAPACITY	SPEED RATIO	OUTPUT CAPACITY
0.00	2.30	28.3	0.01	0.0
0.10	2.15	30.4	0.65	20.0
0.20	2.01	31.1	0.85	40.0
0.30	1.87	31.2	1.00	60.0
0.40	1.73	31.4	0.95	80.0
0.50	1.59	32.2	0.97	100.0
0.60	1.44	34.5	0.99	120.0
0.70	1.29	38.8	1.00	140.0
0.80	1.12	45.8	1.00	160.0
0.90	0.99	59.4	1.00	180.0
1.00	0.95	165.9	1.00	200.0

TRANSMISSION FAN TORQUE LOSS COEFFICIENTS
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE
CONVERTER
0.388960E+02 0.355505E-01 -0.10646E-05 0.000000E+00
LOCKUP
0.388960E+02 0.355505E-01 -0.10646E-05 0.000000E+00

RPM	TRANS FAN LOSS	INPUT LOSS CONV	INPUT LOSS LOCKUP
0	0.0	38.9	38.9
200	0.0	46.0	46.0
400	0.0	52.9	52.9
600	0.0	59.8	59.8
800	0.0	66.7	66.7
1000	0.0	73.4	73.4
1200	0.0	80.0	80.0
1400	0.0	86.6	86.6
1600	0.0	93.1	93.1
1800	0.0	99.4	99.4
2000	0.0	105.7	105.7
2200	0.0	112.0	112.0
2400	0.0	118.1	118.1
2600	0.0	124.1	124.1
2800	0.0	130.1	130.1
3000	0.0	136.0	136.0

COEFFICIENTS FOR TRANS OUTPUT TORQUE LOSS CURVE

GEAR	CONSTANT	X	X**2	X**3
1	0.370579E+02	0.327095E-01	0.114288E-05	0.280044E-09
2	0.489163E+02	0.400539E-01	-0.15701E-04	0.455355E-08
3	0.818664E+02	0.256677E-01	-0.19742E-04	0.630666E-08
4	0.970775E+02	0.977782E-02	-0.17140E-05	0.426055E-08

TRANSMISSION OUTPUT TORQUE LOSS
RPM GEAR 1 GEAR 2 GEAR 3 GEAR 4 GEAR 5 GEAR 6

0	37	49	82	97	0	0
200	44	56	86	99	0	0
400	50	63	89	101	0	0
600	57	68	92	103	0	0
800	64	73	93	106	0	0
1000	71	78	94	109	0	0
1200	78	82	95	114	0	0
1400	86	87	96	119	0	0
1600	93	91	98	126	0	0
1800	101	97	101	134	0	0
2000	109	103	105	144	0	0
2200	118	110	110	156	0	0
2400	126	118	117	170	0	0
2600	135	127	126	186	0	0
2800	144	138	137	205	0	0
3000	153	151	151	226	0	0

TRANSMISSION SHIFT SCENARIO

GEAR 2 CONVERTER
GEAR 2 LOCKUP
GEAR 3 LOCKUP
GEAR 4 LOCKUP

TRANSMISSION GEAR SHIFT VALUES

GEAR	2 CONV		2 LU		3 LU		4 LU	
	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
	0.0	7	0.0	12	0.0	19	0.0	45
	275	7	175	12	175	19	950	45
	950	11	700	18	700	28	950	45
	950	11	1025	18	1000	28	950	45

DATA FOR TRANSMISSION X-1100
WHICH HAS BEEN MATCHED WITH THE FOLLOWING ENGINES

NUMBER	ENGINE NAME
1	RC4-350.RO
2	AGT-1500
3	TWIN-903.1
4	TWIN-903.2
5	TWIN-903'S
6	ONE.903.1
7	ONE.903.2
8	ONE.903.3
9	MTU-871HOT
10	AVCR-1360
11	MACK-E-9
12	TWIN-903'S
13	TWIN-E-9'S
14	TWIN-903.1
15	TWIN-903.2
16	ONE.903.1

```
   17    ONE.903.2
   18    ONE.903.3
   19    RR-CV12HOT
   20    MTU-880HOT
   21    MTU-880CLD
   22  TO RETURN
 ENTER NUMBER TO LIST DATA OR RETURN
>22
 LIST ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 DATABASE HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>CHANGE
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>VEHICLE
  FOLLOWING IS A LIST OF CHANGEABLE VEHICLE ATTRIBUTES:
     1 = VEHICLE NAME
     2 = DEFAULT ENGINE
     3 = DEFAULT TRANSMISSION
     4 = GROSS VEHICLE WEIGHT (LB)
     5 = ACTIVE TRACK WEIGHT (LBM)
     6 = PRIMARY ROAD ROLLING RESISTANCE (LBF/TON)
     7 = SECONDARY ROAD ROLLING RESISTANCE (LBF/TON)
     8 = CROSS COUNTRY ROLLING RESISTANCE (LBF/TON)
     9 = FRONTAL AREA (FT**2)
    10 = AIR DRAG COEFFICIENT (REAL)
    11 = RETURN
  ENTER THE NUMBER OF YOUR CHOICE
>1
 PRESENT VEHICLE NAME IS M-1
  ENTER THE NEW VEHICLE NAME (<11 CHARACTERS)
>M-1E1
 NEW VEHICLE NAME IS  M-1E1
  ENTER THE NUMBER OF YOUR CHOICE
>11
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>ENGINE
 FOLLOWING IS A LIST OF THE CHANGEABLE ENGINE ATTRIBUTES:
     1 = ENGINE NAME
     2 = ENGINE MAXIMUM GROSS HORSEPOWER
     3 = INSTALLATION LOSS FACTOR
     4 = STANDARD TEMPERATURE
     5 = STANDARD ALTITUDE
     6 = RATED ENGINE RPM
     7 = ENGINE IDLE RPM
     8 = ENGINE SPEED FOR SHIFT
     9 = NUMBER OF RPM VS TORQUE OR HORSEPOWER VALUES
```

```
        ENGINE RPM VS GROSS TORQUE OR HORSEPOWER
    10 = ACCESSORY POWER LOSS
    11 = ALTERNATOR POWER LOSS
    12 = ENGINE FAN POWER LOSS
    13 = TEMPERATURE LOSS FACTOR
    14 = ALTITUDE LOSS FACTOR
    15 = ENGINE FUEL CONSUMPTION MAP
    16 = RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>1
 PRESENT ENGINE NAME IS AGT-1500
 ENTER NEW ENGINE NAME (<11 CHARACTERS)
>AGT-2000
 ENGINE NAME IS NOW AGT-2000
 ENTER THE NUMBER OF YOUR CHOICE
>16
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>TRANS
 FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ATTRIBUTES:
    1 = TRANSMISSION NAME
    2 = TRANSMISSION GEAR SHIFT TIME
    3 = TRANSMISSION MOMENT OF INERTIA
    4 = LIST THE COMPATIBLE ENGINES
    5 = CREATE A NEW ENGINE FROM AN EXISTING ONE
    6 = RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>1
 PRESENT TRANSMISSION NAME IS X-1100
  ENTER NEW TRANSMISSION NAME (<11 CHARACTERS)
>X-1300
 TRANSMISSION NAME IS NOW X-1300
 ENTER THE NUMBER OF YOUR CHOICE
>4
      ENGINE   1  RC4-350.RO
      ENGINE   2  AGT-1500
      ENGINE   3  TWIN-903.1
      ENGINE   4  TWIN-903.2
      ENGINE   5  TWIN-903'S
      ENGINE   6  ONE.903.1
      ENGINE   7  ONE.903.2
      ENGINE   8  ONE.903.3
      ENGINE   9  MTU-871HOT
      ENGINE  10  AVCR-1360
      ENGINE  11  MACK-E-9
      ENGINE  12  TWIN-903'S
      ENGINE  13  TWIN-E-9'S
      ENGINE  14  TWIN-903.1
      ENGINE  15  TWIN-903.2
      ENGINE  16  ONE.903.1
      ENGINE  17  ONE.903.2
```

```
     ENGINE  18  ONE.903.3
     ENGINE  19  RR-CV12HOT
     ENGINE  20  MTU-880HOT
     ENGINE  21  MTU-880CLD
 IS A COMPATIBLE ENGINE TO BE CHANGED YES(Y) OR NO(N)
>YES
 ENTER NUMBER OF ENGINE TO BE CHANGED
>2
  THE FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ENGINE DEPENDENT ATTRIBUTES:
     1 - DEPENDENT ENGINE NAME
     2 - CONVERTER DESIGNATION
     3 - ENGINE TO TRANSMISSION GEAR RATIO AND EFFICIENCY
     4 - TRANSFER CASE GEAR RATIO AND EFFICIENCY
     5 - STARTING GEAR
     6 - TRANSMISSION FAN TORQUE LOSS CURVE COEFFICIENTS
     7 - FINAL DRIVE GEAR RATIO AND EFFICIENCY
     8 - SPROCKET PITCH RADIUS
     9 - FINAL DRIVE MOMENT OF INERTIA
    10 - SPEED RATIO VS TORQUE RATIO CURVE COEFFICIENTS
    11 - SPEED RATIO VS INPUT CAPACITY FACTOR CURVE COEFFICIENTS
    12 - OUTPUT CAPACITY FACTOR VS SPEED RATIO CURVE COEFFICIENTS
    13 - ENGINE SPEED FOR LOCKUP
    14 - SPEED RATIO FOR LOCKUP
    15 - TRANSMISSION GEAR RATIO AND EFFICIENCY
    16 - TRANSMISSION GEAR MOMENT OF INERTIA
    17 - TRANSMISSION GEAR MODE
    18 - TRANSMISSION INPUT TORQUE LOSS CURVE COEFFICIENTS
    19 - TRANSMISSION OUTPUT TORQUE LOSS CURVE COEFFICIENTS
    20 - TRANSMISSION SHIFT SCENARIO DATA
    21 - NUMBER OF GEARS
    22 - RETURN
  ENTER THE NUMBER OF YOUR CHOICE
>1
 PRESENT DEPENDENT ENGINE IS AGT-1500
  ENTER NEW DEPENDENT ENGINE NAME (<11 CHARACTERS)
>AGT-2000
  NO ENGINE NAME AGT-2000   IS ON FILE
  IS THIS NAME CORRECT YES(Y) OR NO(N) ?
>YES
  THE DEPENDENT ENGINE NAME IS NOW AGT-2000
  ENTER THE NUMBER OF YOUR CHOICE
>22
 FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ATTRIBUTES:
    1 - TRANSMISSION NAME
    2 - TRANSMISSION GEAR SHIFT TIME
    3 - TRANSMISSION MOMENT OF INERTIA
    4 - LIST THE COMPATIBLE ENGINES
    5 - CREATE A NEW ENGINE FROM AN EXISTING ONE
    6 - RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>5
```

```
     ENGINE   1  RC4-350.RO
     ENGINE   2  ACT-2000
     ENGINE   3  TWIN-903.1
     ENGINE   4  TWIN-903.2
     ENGINE   5  TWIN-903'S
     ENGINE   6  ONE.903.1
     ENGINE   7  ONE.903.2
     ENGINE   8  ONE.903.3
     ENGINE   9  MTU-871HOT
     ENGINE  10  AVCR-1360
     ENGINE  11  MACK-E-9
     ENGINE  12  TWIN-903'S
     ENGINE  13  TWIN-E-9'S
     ENGINE  14  TWIN-903.1
     ENGINE  15  TWIN-903.2
     ENGINE  16  ONE.903.1
     ENGINE  17  ONE.903.2
     ENGINE  18  ONE.903.3
     ENGINE  19  RR-CV12HOT
     ENGINE  20  MTU-880HOT
     ENGINE  21  MTU-880CLD
 ENTER THE NUMBER OF THE ENGINE TO USED (INTEGER)
>2
 ENTER THE NAME OF THE NEW ENGINE (10 CHARACTERS)
>ACT-3000
 FOLLOWING IS A LIST OF CHANGEABLE TRANSMISSION ATTRIBUTES:
    1 - TRANSMISSION NAME
    2 - TRANSMISSION GEAR SHIFT TIME
    3   TRANSMISSION MOMENT OF INERTIA
    4 - LIST THE COMPATIBLE ENGINES
    5 - CREATE A NEW ENGINE FROM AN EXISTING ONE
    6 - RETURN
 ENTER THE NUMBER OF YOUR CHOICE
>6
 CHANGE ROUTINE:  ENTER THE ENTITY (OR ABBREVIATION)
  VEHICLE (V)   ENGINE (E)   TRANS (T)   RETURN (RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>SAVE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 THE VEHICLE CALLED M-1E1       HAS BEEN SAVED ON FILE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 THE ENGINE CALLED AGT-2000   HAS BEEN SAVED ON FILE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
```

```
>TRANS
 THE TRANSMISSION CALLED X-1300     HAS BEEN SAVED ON FILE
 SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>RECALL
 DO YOU WANT DATA FROM THE AMSTA-RG CATALOG YES(Y) OR NO(N)
>YES
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 YOU ALREADY HAVE A VEHICLE
 IT MUST BE DELETED TO LOAD ANOTHER VEHICLE
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 YOU ALREADY HAVE AN ENGINE
 IT MUST BE DELETED TO LOAD ANOTHER ENGINE
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 YOU ALREADY HAVE A TRANSMISSION
 IT MUST BE DELETED TO LOAD ANOTHER TRANSMISSION
 RECALL ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>DELETE
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
 WARNING!!! YOU MAY HAVE PREVIOUSLY CHANGED OR CREATED THE VEHICLE,
 AND THIS DATA HAS NOT BEEN SAVED

 DO YOU WANT TO RETURN TO THE COMPONENT DATA HANDLER
 TO SAVE THIS DATA? YES(Y) OR NO(N)
>NO
 VEHICLE DELETED
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
 WARNING!!! YOU MAY HAVE PREVIOUSLY CHANGED OR CREATED THE ENGINE,
 AND THIS DATA HAS NOT BEEN SAVED

 DO YOU WANT TO RETURN TO THE COMPONENT DATA HANDLER
 TO SAVE THIS DATA? YES(Y) OR NO(N)
```

```
>NO
 ENGINE DELETED
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
 TRANS DELETED
 DELETE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
  VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>QUERY
 DO YOU WANT TO SEE THE AMSTA-RC CATALOG ?  YES(Y) OR NO(N)
>NO
                          USER CATALOGED DATA
   ---------------------------------------------------------------
   VEHICLE WITH ENGINE AND TRANSMISSION   ENGINES    TRANSMISSIONS
   ------------------------------------   ---------  -------------
     M-60        AVDS-1790  CD-850-6A     AVDS-1790    CD-850-6A
     M-1         AGT-1500   X-1100        AGT-1500     X-1100
     RAM.1       318        NP435         318.1        NP435.1
     M-1.X       AGT-1500   X-1100        AGT-1500.X   X-1100.X
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
 COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
  CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
  RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>RETURN
 TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
  COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>SIMULATE
 ENTER CONCEPT TITLE (WHICH WILL APPEAR ON GRAPHS)
 (10 CHARACTERS OR LESS WITH NO BLANKS)
>TEST
 SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
    1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
    2 = FULL POWER ACCELERATION PERFORMANCE
    3 = FUEL CONSUMPTION
    4 = RETURN TO TOP LEVEL CONTROLLER
 ENTER THE NUMBER OF YOUR CHOICE
>1
 DO YOU WANT TO (1)SAVE, (2)SPOOL, (3)DELETE OR (4)CONTINUE
 THE PRESENT TRACTIVE.FORCE.DATA FILE
>3
 IN ROUTINE TO FIND TRACTIVE FORCE VS SPEED
 OUTPUT LISTING WILL BE ON THE FILE TRACTIVE.FORCE.DATA
 THE AMBIENT TEMPERATURE IS    60 DEG F   THE ALTITUDE IS     0 FT
 DO YOU WANT TO CHANGE THESE VALUES  YES(Y) OR NO(N)
>NO
```

```
THE TRACTIVE FORCE VS SPEED SIMULATION IS COMPLETE
OUTPUT FILE IS TRACTIVE.FORCE.DATA
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>2
DO YOU WANT TO, 1(SAVE), 2(SPOOL), 3(DELETE) OR 4(CONTINUE)
THE PRESENT ACCEL.DATA FILE ?
3
 OUTPUT DATA WILL BE ON THE FILE CALLED ACCEL.DATA
IN ROUTINE TO SIMULATE FULL POWER ACCELERATION
 SET THE ROLLING RESISTANCE
1 = PRIMARY ROAD ROLLING RESISTANCE IS    90 LB/TON
2 = SECONDARY ROAD ROLLING RESISTANCE IS 100 LB/TON
3 = CROSS COUNTRY ROLLING RESISTANCE IS  180 LB/TON
4 = OTHER AS DESIRED
>1
THE TRACTION COEFFICIENT IS 0.75
DO YOU WANT TO CHANGE THE TRACTION COEFFICIENT YES(Y) OR NO(N)
>NO
 ENTER ACCELERATION ROUTINE
INITIALIZE DATA
M-1E1     AGT-2000  X-1300
 AVERAGE SPROCKET HP     1054.67     FOR TOP SPEED OF      43.5871
THE FULL POWER ACCELERATION SIMULATION IS COMPLETE
OUTPUT FILE IS ACCEL.DATA
SIMULATION FACILITY: THE FOLLOWING SIMULATIONS/OPERATIONS CAN BE PERFORMED
   1 = FULL THROTTLE TRACTIVE FORCE VS VEHICLE SPEED
   2 = FULL POWER ACCELERATION PERFORMANCE
   3 = FUEL CONSUMPTION
   4 = RETURN TO TOP LEVEL CONTROLLER
ENTER THE NUMBER OF YOUR CHOICE
>4
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>GRAPH
THE TERMINAL TYPE YOU ENTERED (1) DOES NOT HAVE GRAPHING CAPABILITIES
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>STOP
WARNING!!! YOU MAY HAVE PREVIOUSLY CHANGED OR CREATED THE
  VEHICLE
  ENGINE
  TRANSMISSION
AND THIS DATA HAS NOT BEEN SAVED

DO YOU WANT AN OPPORTUNITY TO SAVE THIS DATA?  YES(Y) OR NO(N)
>YES
```

```
REMEMBER, EACH SAVED VEHICLE, ENGINE OR TRANSMISSION MUST HAVE
A UNIQUE NAME.
TOP LEVEL CONTROLLER: ENT[illegible] FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMU[illegible])   GR[illegible](G)   OR   STOP(S)
>DB
COMPONENT DATA HAND[illegible]: ENTER A CO[illegible]ND (OR ABBREVIATION) :
 CREATE(CR)   LIST[illegible]   CHANGE(CH[illegible]   SAVE(S)
 RECALL(R)   DELETE[illegible]   [illegible]   RETURN(RET)
>SAVE
SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
 VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>VEHICLE
THE VEHICLE CALLED M-1E1      HAS BEEN SAVED ON FILE
SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
 VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>ENGINE
THE ENGINE CALLED AGT-1000   HAS BEEN SAVED ON FILE
SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
 VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>TRANS
THE TRANSMISSION CALLED X-1300     HAS BEEN SAVED ON FILE
SAVE ROUTINE: ENTER THE ENTITY(OR ABBREVIATION)
 VEHICLE(V)   ENGINE(E)   TRANS(T)   RETURN(RET)
>RETURN
COMPONENT DATA HANDLER: ENTER A COMMAND (OR ABBREVIATION) :
 CREATE(CR)   LIST(L)   CHANGE(CH)   SAVE(S)
 RECALL(R)   DELETE(D)   QUERY(Q)   RETURN(RET)
>RETURN
TOP LEVEL CONTROLLER: ENTER ONE OF THE FOLLOWING COMMANDS (OR ABBREVIATIONS):
 COMPONENT(CD)   SIMULATE(SIM)   GRAPH(G)   OR   STOP(S)
>STOP
IF SIMULATIONS HAVE BEEN RUN THE FOLLOWING FILES CONTAIN OUTPUT DATA:
   TRACTIVE FORCE VS SPEED ON TRACTIVE.FORCE.DATA
   FULL POWER ACCELERATION ON ACCEL.DATA
   FUEL CONSUMPTION ON FUEL.DATA
OK,
```

APPENDIX E

INFORMATION TO USE GRAFTEK

GRAFTEK is a separate program which can be used to fit curves to data. It can be used to obtain the coefficients for all third order polynomial curve fits (e.g., Speed Ratio vs Torque Ratio and Transmission Input and Output Losses). The program contains an explanation of the different options and can be initiated with the following command: SEG <DRAS02>JACOBSON>GRAFTEK>#GTEK. The program produces several files. The file names are as follows:

F#005: File of actual input data
F#006: Formatted list of input data (Original Data)
F#007: Unknown
F#008: Output listing of curve fit
F#010: Unknown

The following pages show the GRAFTEK screens which provide information on the use of the options and the graph screen. The following steps are required to fit a curve to data points: 1) Select "READ IN NEW DATA" with the cursor. 2) Enter the data at the bottom of the screen in X,Y pairs separated by commas, making sure not to go past the short verticle line. Each line of data points must end with a comma. When all data has been entered and "END OF DATA" has been selected the data points will then be plotted on the graph. 3) When all data points have been entered and plotted select "DISPLAY A CURVE" with the cursor and then select the type of curve shown on the lefthand side of the screen. For a 3rd order polynomial select "3RD" under "POLYNOMIAL". The program will then fit the type of curve selected to the data points and then plot the curve.

Each time a curve is plotted the coefficients are printed to the file F#008 along with the actual X,Y data and the calculated Y data.

DO YOU WISH TO SEE A DESCRIPTION OF THE OPTIONS. PICK

YES NO

-NOTE TO GRAFTEK USERS-

IT IS THE NATURE OF GRAFTEK TO ALLOW THE USER TO SELECT, FROM AMONGST AL
THE POLYNOMIAL AND EMPIRICAL EQUATIONS OFFERED, THE EQUATION (CURVE) WHI
BEST FITS THE DATA SET. TO MAKE IT REASONABLE AND CORRECT TO COMPARE ON
CURVE TO ANOTHER FOR BEST FIT, THE STANDARD ERROR OF ESTIMATE (S SQUARED
ONLY IS USED. THE COEFFICIENT OF DETERMINATION (R SQUARED) WILL NOT BE
USED, SINCE FOR MOST OF THE CURVES THE RESULT CAN NOT BE PROPERLY DETERM
UNLESS A TRANSFORMATION TO A LINEAR EQUATION (AND ASSOCIATED NEW TRANSFO
DATA) IS MADE. THESE TRANSFORMATIONS THEN ONLY LEND THEMSELVES TO THE
RESULTANT NEW DATA SET AND NOT TO EACH CURVE.

NEXT PAGE   FINISHED

READ IN NEW DATA (READ)

CAUSES THE CURRENT SCREEN CONTENTS TO ERASE AND THE NEXT DATA SET TO BE READ. SUBSEQUENTLY, THE NEW DATA POINTS WILL APPEAR SCALED TO FIT NICELY WITHIN THE PROGRAM SUPPLIED AXES.

IF THE DATA SETS HAVE BEEN EXHAUSTED, THERE ARE THREE CHOICES.

1- TYPE IN A NEW DATA SET VIA THE ALPHANUMERIC KEYBOARD, OR

2- REREAD THE OLD DATA SET, OR

3- END GRAF-TEK.

RESCALE AXES (RESC)

SELECTS A SCALE SUCH THAT ALL THE DATA POINTS WILL FIT NICELY WITHIN THE PROGRAM SUPPLIED AXES. THE SCREEN WILL CLEAR AND THE NEW RESCALED AXES WILL APPEAR.

S-L FORM (S-L)

CHANGES THE SCREEN PHRASES TO A SHORT, MORE CRYPTIC DISPLAY. THIS SHORTENS DISPLAY REGENERATION TIME AND TAKES EFFECT THE NEXT TIME THE SCREEN IS ERASED. SELECT AGAIN TO RETURN TO THE LONG FORM. IT IS SUGGESTED THAT A COPY BE MADE OF THE LONG FORM DISPLAY AND USED AS A REMEMBRANCE WHEN THE SHORT FORM OPTION IS IN EFFECT.

DELETE ALL CURVES (D CV)

CLEARS THE SCREEN AND RETURNS A DISPLAY THAT REFLECTS THE CURRENT DATA SET STATUS WITH ALL CURVES ELIMINATED.

NEXT PAGE FINISHED

DELETE POINT(S) (D PT)

ENABLES THE DELETION OF A POINT OR COMBINATION OF POINTS FROM THE DATA SET SO THAT MODIFIED CURVE FITTINGS MAY BE OBTAINED - PERHAPS GIVING A BETTER FIT. IN ORDER TO DELETE A POINT, LOCATE THE CROSS-HAIRS OVER THE DESIRED POINT REPRESENTED BY AN X OR * AND TYPE ANY ARBITRARY CHARACTER. AN O WILL APPEAR OVER THE X OR * INDICATING THAT FUTURE CALCULATIONS ON THE CURRENT DATA SET WILL NOT INCLUDE THE DELETED POINT(S).

ADD NEW POINT(S) (ADD)

ALLOWS THE ADDITION OF NEW DATA POINTS TO THE CURRENT DATA SET VIA THE ALPHANUMERIC KEYBOARD. THE DATA IS ENTERED IN PAIRS OF X AND Y COORDINATES WITH EACH ELEMENT FOLLOWED BY A COMMA. THE DATA IS ENTERED IN FREE FORMAT, WITH OR WITHOUT A DECIMAL POINT, OR CAN BE ENTERED IN E FORMAT NOTATION. MORE THAN ONE LINE OF DATA CAN BE ENTERED. THE ADDED DATA POINTS WILL APPEAR AS AN *.

ORIGINAL POINTS (ORIG)

CLEARS THE SCREEN AND REDISPLAYS THE ORIGINAL SET OF DATA POINTS.

NEW PTS. NOW ORG (NEW)

CLEARS THE SCREEN AND CLEANS UP THE CURRENT DATA SET. ALL DELETED POINTS ARE PERMANENTLY ELIMINATED AND ALL ADDED POINTS ARE PERMANENTLY RETAINED. NOW SELECTING "ORIGINAL POINTS" WILL RETURN THIS CLEANED UP DATA SET.

NEXT PAGE FINISHED

DISPLAY A CURVE (DISP)

ALLOWS FOR THE SELECTION OF ANY OF THE NINE EMPIRICAL OR ELEVEN NTH DEGREE POLYNOMIAL EQUATIONS AT THE LEFT OF THE GRAPH AREA. A MAXIMUM OF THREE CURVES MAY BE DISPLAYED AT ONE TIME. TO DISPLAY ADDITIONAL CURVES THE PHRASE "DELETE ALL CURVES" MUST FIRST BE CHOSEN. ONCE "DISPLAY A CURVE" HAS BEEN SELECTED, EACH OF THE THREE CURVES MAY BE PICKED CONSECUTIVELY WITHOUT RE-SELECTING "DISPLAY A CURVE".

RESTORE DELETED POINTS (REST)

ALLOWS ANY PREVIOUSLY DELETED POINT TO BE RESTORED AND INCLUDED AGAIN IN THE CURRENT DATA SET. PLACE THE CROSS-HAIRS OVER THE DESIRED POINT AND TYPE ANY ARBITRARY CHARACTER. THE O OF THE DELETED POINT WILL BE WRITTEN OVER WITH A $.

REVERSE X AND Y (REVE)

CLEARS THE SCREEN AND REDISPLAYS THE DATA SET WITH THE X VALUES AND Y VALUES INTERCHANGED.

HARD COPY (HARD)

STORES ALL NECESSARY INFORMATION ABOUT THE LAST DISPLAYED CURVE ON TO A DISK STORAGE FILE WITH LOCAL FILE NAME PLOT. CATALOGING PLOT AT THE CONCLUSION OF GRAF-TEK WILL SAVE THE FILE SO THAT A CAL-COMP DRUM PLOT CAN BE PREPARED AT A LATER TIME BY RUNNING THE GRAF-TEK PLOT PROGRAM.

NEXT PAGE FINISHED

CONNECT POINTS (CONN)

WHEN CALLED ONCE, THIS OPTION WILL CONNECT EACH CURRENT POINT WITH
A STRAIGHT LINE. WHEN CALLED AGAIN, THIS OPTION WILL BE TURNED OFF.

ZOOM (ZOOM)

ALLOWS A FULL SCREEN DISPLAY OF THE LAST SELECTED CURVE WITHOUT THE
LIST OF EQUATIONS, THE LIST OF OPTIONS, OR ANY OTHER RESULT INFORMATION.
WHEN ZOOM IS COMPLETE, THE CROSSHAIRS APPEAR. TYPING ANY CHARACTER
RETURNS TO GRAFTEK WITH ALL CURVES DELETED.

NEXT PAGE FINISHED

SPECIFY CONSTANTS (SPEC)

ALLOWS EXPERIMENTATION ON ANY EMPIRICAL EQUATION SELECTED TO FIT THE DATA. A CURVE IS SELECTED IN THE NORMAL FASHION AND ITS RESULTS DISPLAYED. THEN ANY OF THE CALCULATED CONSTANTS CAN BE MODIFIED TO SEE THEIR AFFECT. SELECTING THE PHRASE "DISPLAY" WILL CAUSE THE MODIFIED EQUATION TO BE PLOTTED AND ITS RESULTS TO APPEAR. TO CHANGE MORE THAN ONE CONSTANT, SELECT THE PHRASE "ENTER". ONLY ONE EMPIRICAL EQUATION CAN BE WORKED ON AT A TIME. THERE ARE ONLY TWO PHRASES THAT CAN BE SELECTED TO GET OUT OF THIS OPTION, AND THEY ARE "DONE" AND "END OF PROGRAM" (END).

CHANGE TITLE (CHAN)

ALLOWS THE CURRENT TITLE TO BE CHANGED TO A NEW TITLE. UP TO 78 CHARACTERS ARE ALLOWED AND IT WILL REAPPEAR IN ITS NORMAL POSITION THE NEXT TIME THE SCREEN CLEARS.

PUNCH DECK (PUNC)

GIVES PUNCH DECK OUTPUT WHICH CONTAINS ANY ADDED AND ALL NON-DELETED POINTS REPRESENTING THE CURRENT DATA SET.

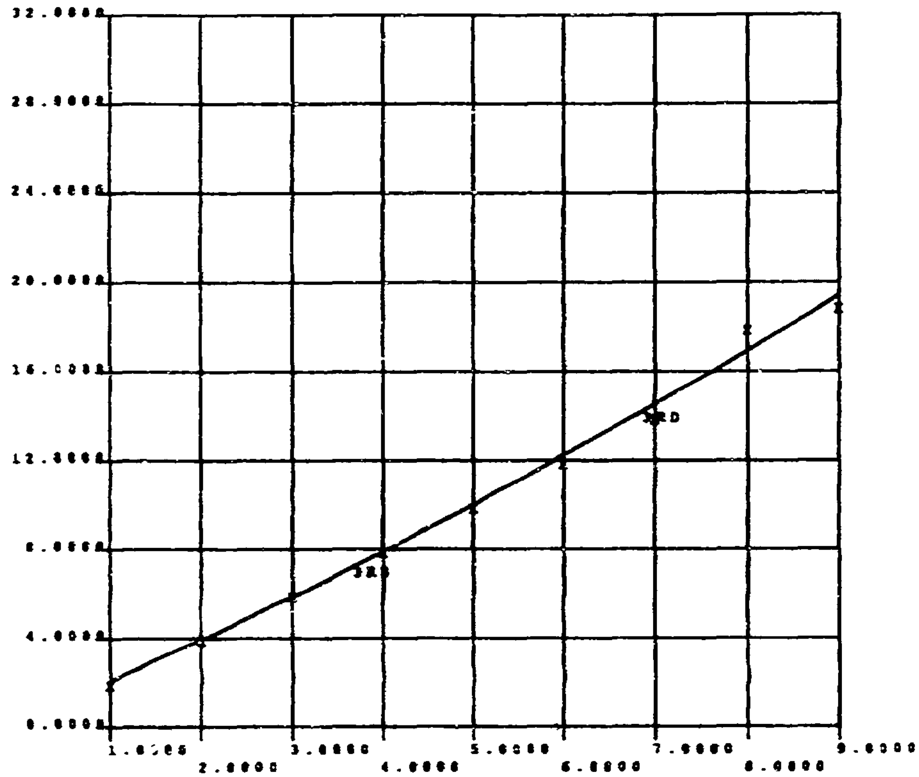
END OF PROGRAM (END)

TERMINATES GRAF-TEK AND CLEARS THE SCREEN.

POLYNOMIAL/EMPIRICAL

1ST	1	$Y = A+BX$
2ND	2	$Y = AX^{B}$
3RD	3	$Y = AE^{BX}$
4TH	4	$Y = \frac{X}{A+BX}$
5TH	5	$Y = AX^{B}+C$
6TH	6	$Y = AE^{BX}+C$
7TH	7	$Y = A+BX+CX^{2}$
8TH	8	$Y = \frac{X}{A+BX}+C$
9TH	9	$Y = AE^{BX+CX^{2}}$
10TH		E = 2.7182818
11TH		

NO. OF POINTS = 9
BEST FIT = 3RD



OPTIONS

READ IN NEW DATA
RESCALE AXES
S-L FORM
DELETE ALL CURVES
DELETE POINT(S)
ADD NEW POINT(S)
ORIGINAL POINTS
NEW PTS. NON ORG.
DISPLAY A CURVE
CONNECT POINTS
ZOOM
RESTORE DELETED POINT(S)
REVERSE X AND Y
SPECIFY CONSTANTS
HARD COPY
CHANGE TITLE
PUNCH DECK
END OF PROGRAM

CURVE 3RD
A =
B =
C =
STAND. ERROR
OF ESTIMATE= 0.4342

RSQ= 0.9940

END OF LINE END OF DATA
PLEASE TYPE IN X AND Y COORD. IN PAIRS EACH NUMBER FOLLOWED BY A COMMA.
1,2,2,4,3,6,4,8,5,10,6,12,7,14,8,18,9,19.

IF YOU WISH TO RUN A NEW SET OF DATA POINTS, YOU MAY TYPE IT IN VIA THE KEYBOARD. FIRST RE-HIT "READ IN NEW DATA". IF NOT HIT "END OF PROGRAM" OR, IF YOU WISH TO REREAD YOUR DATA, SELECT "ORIGINAL POINTS" PHRASE

APPENDIX F

INFORMATION TO USE FUEL MAP PROGRAM

This program has the capability of digitizing an engine fuel map and producing a datafile that can be read into the simulation. Contact Richard Jacobson (Ext. 45879/45999) for information on using this program.

APPENDIX G

MATCHING AN ENGINE WITH A TRANSMISSION

In order to obtain good performance from the simulation, the Hydrokinetic transmissions must be properly matched to the engine.This matching is difficult.

It encompasses such things as:

- o Proper Engine Power
- o Proper Converter Characteristics

When a converter and engine are mismatched the engine may reach maximum speed at a low speed ratio or the engine may operate at a low speed and not reach peak torque over the range of speed ratios. To obtain information on matching a non-standard combination of engine and transmission contact Richard W. Jacobson AMSTA-RY 45879/45999.

If simulation results appear incorrect or the simulation abnormally terminates, contact Richard Jacobson. In the case where the simulation abnormally terminates, obtain a copy of the traceback and any partial output files to assist in locating the problem.

APPENDIX H

BLANK VEHICLE DATA SHEET

The following page is a blank Vehicle Data Sheet.

VEHICLE DATA SHEET

VEHICLE NAME = ____________________

DEFAULT ENGINE = ____________________

DEFAULT TRANSMISSION = ____________________

GROSS VEHICLE WEIGHT = ____________________ LB

This is the weight of the track that is not on the ground.

ACTIVE TRACK WEIGHT = ____________________ LB

Rolling resistance for wheeled vehicles on hard surface is around 30 lb/ton. Army tracked vehicles are generally 3 times this amount. Secondary road rolling resistance is approximately 10% greater and cross country rolling resistance is about 100% greater.

PRIMARY ROAD ROLLING RESISTANCE = ____________________ LB/TON

SECONDARY ROAD ROLLING RESISTANCE = ____________________ LB/TON

CROSS COUNTRY ROLLING RESISTANCE = ____________________ LB/TON

FRONTAL AREA = ____________________ FT**2

Air drag coefficients of different vehicles are as follows:

Trucks	.8 to 1.5
Van body	.5 to .7
Car	.3 to .5

AIR DRAG COEFFICIENT = ____________________

APPENDIX I

BLANK ENGINE DATA SHEET

The following 2 pages are the blank Engine Data Sheet.

ENGINE DATA SHEET
(PAGE 1)

ENGINE NAME	=	________	
ENGINE MAXIMUM HORSEPOWER	=	________	HP
INSTALLATION LOSS FACTOR LESS THAN OR EQUAL TO 1.000	=	________	
STANDARD TEMPERATURE	=	________	DEG F
STANDARD ALTITUDE	=	________	FT
RATED ENGINE RPM	=	________	RPM
ENGINE IDLE RPM	=	________	RPM
ENGINE SPEED FOR SHIFT	=	________	RPM
ENGINE MOMENT OF INERTIA	=	________	FT-LB-SEC**2

ENGINE RPM VS GROSS TORQUE

RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF	RPM	FT-LBF
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____

The following engine data is fitted to third order polynomial equations. In order to find the coefficients the program GRAFTEK can be used. See Appendix E on the use of this program.

COEFFICIENTS TO ENGINE TORQUE LOSS CURVES

	CONSTANT	X	X**2	X**3
ACCESSORY	____	____	____	____
ALTERNATOR	____	____	____	____
ENGINE FAN	____	____	____	____

COEFFICIENTS TO TEMPERATURE AND ALTITUDE CORRECTION FACTOR CURVES

TEMPERATURE	____	____	____	____
ALTITUDE	____	____	____	____

ENGINE DATA SHEET
(PAGE 2)

The data in the engine fuel consumption map must be filled out completely in order for the simulation to operate properly. Data values are in BSFC (lb/hp-hr). Data outside the full power curve and at the zero points on the axis is developed by straight line extrapolation. There is a program available to digitize an engine fuel map and put that data into the correct format for this simulation, Appendix F describes the use of this program and the required inputs. Contact Richard Jacobson 45879 on the use of this program.

FUEL CONSUMPTION ENGINE SPEED STEP SIZE = ____________________

NUMBER OF ENGINE RPM POINTS INCLUDING ZERO = ____________________

NUMBER OF HORSEPOWER POINTS INCLUDING ZERO = ____________________

SAMPLE ENGINE FUEL CONSUMPTION MAP

SPROCKET HORSEPOWER

Ø

Ø

ENGINE RPM

APPENDIX J

BLANK TRANSMISSION DATA SHEET

The following 4 pages are the blank Transmission Data Sheet.

TRANSMISSION DATA SHEET
(PAGE 1)

TRANSMISSION NAME	=	______________	
TRANSMISSION TYPE	=	HYDROKINETIC ______________ MECHANICAL ______________	
TRANSMISSION GEAR SHIFT TIME	=	______________	SEC
TRANSMISSION INPUT MOMENT OF INERTIA	=	______________	FT-LB-SEC**2
NAME OF ENGINE MATCHED TO THIS TRANSMISSION	=	______________	
IF TYPE=HYDROKINETIC, CONVERTER NAME	=	______________	
ENGINE TO TRANSMISSION GEAR RATIO	=	______________	
ENGINE TO TRANSMISSION GEAR EFFICIENCY	=	______________	
TRANSFER CASE GEAR RATIO	=	______________	
TRANSFER CASE GEAR EFFICIENCY	=	______________	
FINAL DRIVE GEAR RATIO	=	______________	
FINAL DRIVE GEAR EFFICIENCY	=	______________	
FINAL DRIVE MOMENT OF INERTIA	=	______________	FT-LB-SEC**2
SPROCKET PITCH RADIUS	=	______________	FT
NUMBER OF GEARS	=	______________	
NORMAL STARTING GEAR	=	______________	

TRANSMISSION DATA SHEET
(PAGE 2)

The next three items are the torque converter characteristics of a hydrokinetic type transmission. This data is fitted with third order polynomial equations. In order to find the coefficients the program GRAFTEK can be used. See Appendix E on the use of this program.

The data can be fitted to either 1 or 2 curves. If one curve is used then the speed ratio at which the curves change must be 1.0 and the coefficients for curve 2 are set to zero. If 2 curves are used then all three data items must change at the same speed ratio.

SPEED RATIO AT WHICH THE CURVES CHANGE = ____________________

COEFFICIENTS TO THE TWO SPEED RATIO VS TORQUE RATIO CURVES

	CONSTANT	X	X**2	X**3
CURVE 1				
CURVE 2				

COEFFICIENTS TO THE TWO SPEED RATIO VS INPUT CAPACITY FACTOR CURVES

CURVE 1				
CURVE 2				

COEFFICIENTS TO THE TWO OUTPUT CAPACITY FACTOR VS SPEED RATIO CURVES

CURVE 1				
CURVE 2				

TRANSMISSION FAN TORQUE LOSS COEFFICIENTS

COEFFICIENTS FOR TRANS INPUT TORQUE LOSS CURVE

CONVERTER				
LOCKUP				

COEFFICIENTS FOR TRANS OUTPUT TORQUE LOSS CURVE

GEAR	CONSTANT	X	X**2	X**3
1				
2				
3				
4				
5				
6				

The following data items require 1 entry for each gear ratio. The simulation can accept transmissions with up to 6(six) gear ratios.

The transmission GEAR MODE represents the capability of a hydrokinetic type transmission the modes are:

TRANSMISSION GEAR MODE = 1 (CONVERTER ONLY)
= 2 (LOCKUP ONLY)
= 3 (BOTH CONVERTER AND LOCKUP)

When the transmission type is MECHANICAL then the TRANSMISSION GEAR MODE must be 2 for every gear.

TRANSMISSION GEAR MODE
1 = ______
2 = ______
3 = ______
4 = ______
5 = ______
6 = ______

CONVERTER SPEED RATIO FOR LOCKUP
1 = ______
2 = ______
3 = ______
4 = ______
5 = ______
6 = ______

TRANSMISSION GEAR RATIO
1 = ______
2 = ______
3 = ______
4 = ______
5 = ______
6 = ______

TRANSMISSION GEAR EFFICIENCY
1 = ______
2 = ______
3 = ______
4 = ______
5 = ______
6 = ______

TRANS GEAR OUTPUT MOMENT OF INERTIA
1 = ______
2 = ______
3 = ______
4 = ______
5 = ______
6 = ______

TRANSMISSION DATA SHEET
(PAGE 4)

The following data is used in the fuel consumption simulation. The TRANSMISSION SHIFT SCENARIO is the normal gear shifting sequence when the vehicle is accelerating or decelerating. The TRANSMISSION GEAR SHIFT VALUES represent a shift line for the particular gear condition; these are sets of horsepower and vehicle speed values, across which the transmission will shift to the next gear in the TRANSMISSION SHIFT SCENARIO. There will only be TRANSMISSION GEAR SHIFT VALUES for the conditions which have a 1 in the TRANSMISSION SHIFT SCENARIO.

TRANSMISSION SHIFT SCENARIO

GEAR	CONVERTER	LOCKUP
1	____	____
2	____	____
3	____	____
4	____	____
5	____	____
6	____	____

TRANSMISSION GEAR SHIFT VALUES

CONVERTER

GEAR	1		2		3		4		5		6	
ITEM	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
1	____	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____	____

LOCKUP

GEAR	1		2		3		4		5		6	
ITEM	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED	HP	SPEED
1	____	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____	____

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